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FUNDAMENTAL SKILLS TUTORING PROJECT YEAR III DAYTON, OHIO AREA

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13. ABSTRACT *(Maximum 200 words)*

The Intelligent Training Branch of the Technical Training Research Division of the Air Force Armstrong Laboratory is developing a series of software packages designed to train high school students in Algebra, English and Life Science classes in problem solving and critical thinking. The Alliance for Education was awarded a grant from the Air Force Laboratory to assist Armstrong Laboratory in its research by developing local research sites in Dayton area schools to test the effectiveness of the tutors as they are developed.

The Alliance for Education was tasked with selecting schools, purchasing, installing and maintaining hardware, supporting local teachers and administrators, assisting Armstrong Laboratory personnel with implementation of their research program.

Year Three of this project involved continued research on an Algebra word problem solving tutor and an English reading/writing tutor, training additional teachers, retraining past teachers on operation of newer versions of the software, installation of upgraded equipment, provisions for technical support, public relations, program evaluation and preparation for the new Life Science tutor.

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SECTION 1.0: INTRODUCTION

1.1 Background

The U.S. Air Force's Armstrong Laboratory at Brooks Air Force Base in San Antonio, Texas is researching the application of the Air Force's artificial intelligence technology in public schools through a series of computer-based tutors using Intelligent Tutoring Systems (ITS) technology.

Wright Laboratory at Wright-Patterson Air Force Base (WPAFB) signed a Memorandum of Understanding with all of the Air Force's superlabs to support Armstrong Laboratory's research. Wright Laboratory then enlisted the assistance of the Alliance for Education and awarded the Alliance a grant to administer and implement the local component of the project.

The Alliance for Education is a nonprofit organization which is a coalition of industry, education and government, acting as a third-party advocate to improve education. The Alliance for Education is independent of local school districts, but works closely with them. The Alliance for Education developed the title "Project F.A.S.T. Track" (Fundamental Academic Skills Training) for reference to the local component of this national project.

Wright Laboratory originally awarded the grant to the Alliance for Education in 1992 for one year with a renewal option for two additional years. Delays in software development at Armstrong laboratory resulted in an extension of the project for one additional year. This report covers activities during Year Three of the project. Refer to WL-TR-94-4023 for information concerning Year One of the project and WL-TR-95-4005 for information concerning Year Two.

Activities for the first year involved site selection, site preparation, teacher training and support, provision of technical support, public relations and program evaluation. Activities for Year Two involved research on an Algebra word problem solving tutor and an English reading and writing tutor, training additional teachers, retraining past teachers on operation of newer versions of the software, installation of additional equipment, provisions for technical support, public relations and program evaluation.

1.2 Definition of Terms

- **Artificial Intelligence (AI) Technology:** Computer programs that attempt to achieve some type of intelligent behavior
- **FST:** (acronym for Fundamental Skills Training) Program developed by Armstrong Laboratory.
- **ISIS:** (acronym for Instruction in Scientific Inquiry Skills), a Life Science Tutor, primary focus for Year Four research
- **Intelligent Tutoring Systems (ITS) Technology:** Application of artificial intelligence that enhances the power of computer-based instruction by acting like an expert private tutor
- **R-WISE:** (acronym for Reading and Writing In a Supportive Environment) Reading and Writing Tutor, primary focus for Year Two research
- **WPS:** (acronym for Word Problem Solving Tutor), primary focus for Year One research

SECTION 2.0: LOCAL PROJECT OBJECTIVES

The Alliance for Education has organized and administered the local project to meet the following objectives:

I. **To obtain research data on the effectiveness of the Intelligent Tutoring System (ITS) of the Fundamental Skills Training Program for Armstrong Laboratory *by establishing regional testing sites.***

- Primary responsibility for research design rests with the Air Force's Armstrong Laboratory in San Antonio, Texas. Wright Laboratory at Wright-Patterson Air Force Base signed a Memorandum of Understanding with all of the Air Force's superlabs to support Armstrong Laboratory's research. Wright Laboratory then enlisted the assistance of the Alliance for Education and awarded the Alliance a grant to administer and implement the local component of the project.
- F.A.S.T. Track computer laboratories have been established at Dayton Dunbar and Trotwood-Madison High Schools.
- 43 classes of 908 students used Dayton Dunbar and Trotwood-Madison High School F.A.S.T. Track computer labs an average of one day per week during the 1994-1995 school year.
- The project collected data from both Dunbar and Trotwood-Madison High Schools and forwarded it to Armstrong Laboratory. It included
  - English and mathematics teachers' pre-and post-experience attitude surveys
  - English students' on-line pre-and post-tests.
  - Mathematics students' on-line pre-and post-tests.
  - Mathematics and English students' on-line "journals" and "thought logs" in which they recorded personal observations regarding lab activities and the tutors.
- In cooperation with Armstrong Laboratory, the local project research team conducted qualitative and quantitative research projects involving teachers and students.

II. **To deliver individualized instruction through transferring the technology of artificial intelligence applications to two public education systems in the Dayton area in**

(a) a pre-algebra word problem solving tutor
(b) an English reading and writing tutor

- Each school lab contains 28 networked computer stations for student use
- In September, 1994, Armstrong Laboratory provided the Alliance with new versions of the WPS and R-WISE Tutors for use in the Dunbar and Trotwood-Madison High School F.A.S.T. Track computer labs.
- 28 ninth grade English and 15 mathematics classes used the F.A.S.T. Track computer labs an average of one day per week.

- Mathematics teachers selected curriculum "modules" (e.g., Algebraic equations, area or perimeter of triangles, decimals, percentages, or ratios) for each lab session. Then students worked through problems as their pace and in a somewhat random order so that all were not on the same problem at the same time.
- Classes had access to all R-WISE tools, including those in which artificial intelligence was imbedded. Those tools included "Cubing" for idea development, "Idea Board" for brainstorming and outlining, and "Re-vision" for editing.

III. To support school districts' efforts to increase student test scores on the Ohio Proficiency Test in (a) mathematics and (b) reading and writing.

- During Year Three, local evaluators focused on the correlation between Ohio Proficiency Test performance and WPS/R-WISE usage.
- Dayton district personnel, including administrators and teachers, credit their cohesive, committed Dunbar teaching staff, as well as student use of the F.A.S.T. Track Tutors with the significant increase in Dunbar students' scores on the Ohio Proficiency Test.
- Trotwood-Madison teachers began taking Workshop class students (tenth and eleventh grade students who have not yet passed the mathematics portion of the Proficiency Test) to the F.A.S.T. Track Lab in 1993-1994 and continue doing so this year.

SECTION 3.0: ALLIANCE PROJECT RESPONSIBILITIES

During Year Three, the task of the Alliance for Education was responsible for coordinating all facets of the local project, including the following:

I. Ensure Training and Support for Teachers and Site Coordinators

- Arranged for four Trotwood-Madison and Dayton biology teachers, site coordinators, and a Dayton school district science specialist to attend the ISIS training session in San Antonio, Texas in August, 1995.
- Held preliminary and follow-up sessions with biology teachers to supplement the training received in San Antonio.
- Regularly communicated with school site coordinators and met periodically with teachers and district personnel to ensure adequate support. Forwarded information to Armstrong Lab.
- Organized two joint meetings to address teacher concerns and research issues with Armstrong Lab personnel, English teachers, site coordinators, district supervisors and local team members.
- Reimbursed Dayton and Trotwood-Madison districts for the equivalent of one class period per day of each site coordinator's time to ensure adequate time to perform their duties.
- Paid stipends to participating English and mathematics teachers and site coordinators in recognition of their additional responsibilities.

II. Facilitate the Local Project Team To Implement and Oversee the Project Goals and Ensure Adequate Staff and Technical Support

- Served as liaison for teachers, district administrators, and Air Force personnel at both Wright Laboratory and Armstrong Laboratory to ensure research issues were addressed.
- Contracted with the University of Dayton Research Institute for the services of Katie Thorp, associate research engineer, to provide technical assistance to the project and to assist the local evaluation team.
- Contracted with Dr. Phillip Messner, Wright State University associate professor of Educational Leadership, to lead the local research team during Year Three. Also contracted with Dr. Messner's research assistant, Hang Pham.
- Contracted with SelectTech Services, Inc. to ensure that qualified computer technicians were in the computer laboratories with teachers and students at all times for immediate resolution of any hardware or software problems or questions and to protect the integrity of the research.
- Scheduled and assisted Armstrong Laboratory personnel with proctoring pre- and post-tests required for research, and ensured transfer of research data.
- Submitted local status and technical reports and recommendations to Wright Laboratory regarding project accomplishments and future directions.

III. Ensure Site and Equipment Needs for Research Are Met

- Supervised the upgrading of the monitors in both F.A.S.T. Track laboratories to accommodate student use of the anticipated ISIS software.
- Requested quotes for the upgrading of servers in both F.A.S.T. Track laboratories.

IV. Effectively Administer All Grant Funds

- Significant carryover funds at the end of Year Three thus requiring a smaller outlay by Wright Laboratory for Year Four.
  - ✓ Flexibility provided by contracting for technicians' time resulted in significant savings.
  - ✓ Costs to prepare school labs for Year Three were less than anticipated.
  - ✓ Armstrong Lab initiated fewer meetings than anticipated for various site representatives which resulted in lower travel costs.
  - ✓ Publication and reporting costs were lower than anticipated.
  - ✓ Less time than anticipated was required from the technical assistant/liason and the education consultants.
  - ✓ A new program coordinator was hired at a lower salary in May, 1995.
  - ✓ A new control group was not used in the study as planned, therefore fewer teachers' stipends were necessary.
  - ✓ The WPAFB administrator was not hired as planned.
  - ✓ Additional money for Wright Connection is still available in the budget. This money will be used in December, 1995.

SECTION 4.0: YEAR THREE TIMELINE

November 10, 1994	**Program Manager and Site Coordinators** attended the Point of Contact Meeting in Albuquerque, New Mexico to evaluate program's progress.
January 18-19, 1995	**Armstrong Laboratory personnel conducted R-WISE and WPS post-testing** at Dunbar and Trotwood-Madison High Schools.
March, 1995	**Local project replaced VGA monitors with Super VGA monitors** at Dayton Dunbar and Trotwood-Madison High Schools at the direction of Armstrong Laboratory personnel who directed that the enhanced monitors were necessary to accommodate the ISIS Tutor.
May 17, 1995	**Armstrong Laboratory personnel conducted** a demonstration of the ISIS demonstration at Dunbar High School for eight (8) Dunbar and Trotwood-Madison biology teachers.
May 17-18, 1995	**Armstrong Laboratory personnel conducted R-WISE post-testing** at Dunbar and Trotwood-Madison High Schools.
August 7-9, 1995	**Project trained four (4) Dunbar and Trotwood-Madison biology teachers in San Antonio, Texas to use the Air Force's ISIS Tutor** and incorporate its use into their classroom instruction.
August 31, 1995	**Armstrong Laboratory Personnel reported** the results of Year Two research to Dayton and Trotwood-Madison school district, Alliance and Wright Laboratory personnel, including Colonel Davis.
September, 1995	**New servers ordered for computer labs** at Dunbar and Trotwood-Madison

SECTION 5.0: YEAR THREE AS A MAINTENANCE YEAR

5.1 Maintenance Year

Due to the fact that the ISIS Tutor, originally scheduled for field-testing in local schools during the 1994-1995 academic year, was not ready for distribution to the schools, Armstrong Laboratory proposed that Year Three of the project become a *maintenance year* for the R-WISE and WPS tutors. Armstrong Laboratory continued to collect data for English and mathematics classes using the R-WISE and WPS software programs, provided minor up-grades for those programs, and continued development of the ISIS tutor planned for delivery to schools in the fall of 1995.

The local team then defined Year Three as a maintenance year in which:

- There would be no major equipment purchases since only upgrades of current software would be installed. However, upgraded monitors were purchased in preparation for the Year Four specifications required for operation of the ISIS Tutor.
- The local project would continue to fund full-time technical support throughout the year in order to ensure that the computer laboratories would be operational for Year Four research.
- School districts would determine which English and mathematics classes would use the computer laboratories, taking into consideration Armstrong Laboratory's request for English classes to have top priority.

5.2 Year Three Research Design

5.2.1 Reading and Writing (R-WISE) Tutor

5.2.1.1 Description of the Tutor

The version of the R-WISE Tutor which was field tested during Year Three was designed to improve ninth grade English students' writing skills. The reading instructional portions of the tutor were omitted and the tutor was used exclusively for instruction various stages of the writing process including; pre-writing, drafting, revision and editing. Embedded in the tutor were guides that enabled students to seek help as needed for their individual writing concerns.

The philosophy of the R-WISE computer laboratory program involves a three-step process: (1) classroom preparation/teaching, (2) computer lab experience and (3) classroom follow-up/review.

5.2.1.2 R-WISE Research Design

There were no "non-treatment" group classes involved in the computer laboratories during Year Three. Instead, Armstrong Laboratory installed two versions of the R-WISE software and designed a series of research questions around these two versions of the tutor. The "lean" version provided *unsolicited* advice to the students and included many illustrated examples and models. The other version of the tutor was termed the "rich" version. It was slightly more complicated and was geared toward higher level students. The "rich" tutor provided *solicited* advice, which

students could choose to request in the form of (1) diagnosing a specific problem and selecting a way to repair it, (2) a mini-lesson on a specific writing skill or (3) recommended specific action.

Initially, all of the English teachers used the "lean" version of the tutor. After a few months some of the teachers switched to the "rich" version.

5.2.1.3 Armstrong Laboratory's Role in Evaluation

As the project's primary research team, Armstrong Laboratory administered a series of tests including attitudinal surveys and writing samples at the beginning and end of the school year. Armstrong Laboratory contracted with outside evaluators to score the writing samples based on (1) holistic criteria which addressed the overall quality of the writing samples and (2) analytic criteria which addressed specific writing skills including abstraction, organization, purpose and development. Armstrong Laboratory agreed to disseminate their research findings to all the test sites when the data becomes available.

TABLE 1: Local High School Groups Involved in Year Three Research

SCHOOL	SUBJECT	TUTOR	CLASSES	STUDENTS
Dunbar	Algebra I, Part I	WPS	4	67
Dunbar	English 9	R-WISE	12	254
Dunbar	Language Arts 10	R-WISE	2	41
Sub-Total			**18**	**362**
Trotwood	Practical Algebra	WPS	4	82
Trotwood	Workshop	WPS	7	118
Trotwood	English 9	R-WISE	14	346
Sub-Total			25	546
TOTAL			**43**	**908**

Note: *Students may have been assigned to both ninth grade English and mathematics classes using the computer labs. Therefore, those individual students may have been counted twice. Algebra I, Part I is the first section of a two-year Algebra course. Practical Algebra is a one-year, less in-depth Algebra course. Workshop classes are for students in grades 10-12 who have not passed the Ohio Proficiency Test and require additional intervention.*

5.2.2 Word Problem Solving (WPS) Tutor

5.2.2.1 Description of the Tutor

The WPS Tutor, which was initially field tested during Year One of the project, was designed to teach ninth-grade pre-Algebra students word problem solving skills. In addition, the tutor provides instruction in specific topic areas addressed in a typical pre-Algebra course. The WPS problem solving strategy incorporates four cognitive activities: identifying the problem, representing the problem, solving the problem and reflecting on the problem.

5.2.2.2 WPS Research Design

Pre-Algebra and Workshop classes continued to use the FST computer laboratories at both schools. Use of the labs was left open to the schools. Several teachers elected to continue using the labs with their classes, while other teachers elected for a more traditional approach.

5.3 Local Quantitative Research Project

In cooperation with Armstrong Laboratory and local school districts the local research team conducted a quantitative research project during Year Three. The purpose of this research activity was to determine the effect, if any, of the use of the tutors on the ability of the students to improve their performance on and/or pass related sections of the Ohio Proficiency Test. This test is a ninth-grade level test administered state-wide. Passage of the test is required to receive a diploma upon graduation. Data relating to students who used either of the tutors during the 1993-1994 or 1994-1995 school years were included in this study.

The local research team's report, entitled *Fundamental Skills Tutor Correlation with Ohio Proficiency Test Data for the 1993-1994 & 1994-1995 School Years* is attached as Appendix A.

SECTION 6.0: YEAR FOUR (1995-1996)

In Year Four, the third tutor, ISIS (Instruction in Scientific Inquiry Skills), will be implemented at Dunbar and Trotwood-Madison High Schools. The primary goal of the ISIS tutor is to teach students the cognitive skills underlying the principles of scientific inquiry. Specifically, students will understand and demonstrate how to generate a hypotheses, design an experiment to test that hypothesis, conduct the experiment in a simulated ecosystem, draw conclusions about the experiment, and accept or reject the hypothesis.

The secondary goal of the ISIS software is to address introductory high school biology in the area of ecological concepts and relationships. Understanding of these concepts increase student potential for becoming scientifically literate, functional, and critical.

The ISIS instructional approach includes an initial skills presentation with Computer Based Training, student performance of particular skills within an intelligent environment, encyclopedia-like presentation of domain concepts within intelligent environments, and assignment selection based on the levels of difficulty and student proficiency.

There are approximately 45 major domain concepts embedded in ISIS including biomes (e.g., grasslands, deserts, temperate deciduous forests); biotic factors (e.g., carbon dioxide, rainfall, sunlight); atmospheric conditions (e.g., greenhouse effect, pollutants); and ecological relationships (e.g. succession, symbiosis).

During Year Four the Alliance for Education will continue to ensure the coordination of site and equipment needs for successful implementation of the ISIS tutor, as well as continued use of both the R-WISE and the WPS tutors in the labs.

SECTION 7.0: NEXT STEPS

1. In order to increase the statistical significance of the local research findings, additional data from the 1995-1996 school year will be added to the current statistical database.

2. The project is currently planned for completion at the end of Year Four. Future direction for this project and related activities must be determined with recommendations made to the appropriate groups.

3. Decisions must be made regarding placement of existing, dedicated F.A.S.T. Track computer equipment (Super VGA monitors, CPU's and keyboards) currently on loan to the schools upon conclusion of this project.

SECTION 8.0: ADDITIONAL ACTIVITIES

Examples of additional programs administered by the Alliance for Education and partially funded by the F.A.S.T Track grant are *Project GEMMA, Wright Connection and* T^4.

- Project GEMMA (Growth in Education through a Mathematical/Scientific Mentorship Alliance) was designed in 1990 to provide experiences for high school to explore science and mathematics in the world beyond the classroom walls. Nearly 100 teachers in Montgomery and Greene Counties participated in summer internships at local business, industry or government sites where they actively took on "real world" work experiences designed to provide meaningful classroom transfer opportunities. Supported by a partnership of representatives from Dayton area businesses, WPAFB's Wright Laboratory, schools and universities, the cornerstones of the project include
  - **One-on-one business mentoring**
  - **Seminars**
  - **Strategies** to transfer lessons learned to the classroom
  - **Dissemination activities** including site visitations for additional teachers and school-year symposiums.

- ***Project Wright Connection*** is an expansion of ***Project GEMMA*** and began in 1995 when the Alliance was awarded over $2 million from the National Science Foundation. A partnership between the Alliance, Wright-Patterson Air Force Base's Wright Laboratory, area businesses, the Engineering and Science Foundation and Miami Valley schools. Project Wright Connection now provides opportunities for teachers in 14 counties to participate. The project continues to support meaningful summer internships as the cornerstone of learning. Many of the placements are at WPAFB.

  Grants for classroom activities through ***Wright Connection*** provide resources for educators to implement new techniques that address topics such as critical thinking, technology, scientific process and cooperative learning. Over 300 direct participants and hundreds of other school team members will benefit from Project Wright Connection as networks are established and teachers gain the skills necessary to prepare students for the workplace of the future.

- T^4 is an initiative to support work with the Disney Celebration Teaching Academy, Stetson University and the Osceola School District to research Air Force technology applications for adaptation to K-12 schools. Activities involve
  - Ascertaining the current state of educational technology.
  - Identifying current technologies used in the areas of mathematics, science and reading/writing/communications education that can be advanced with an infusion of Air Force technology.
  - Facilitating the initial steps of the infusion process by producing a report to communicate the results of the partnership study.

APPENDIX A

Fundamental Skills Tutor Correlation with Ohio Proficiency Test Data for the 1993-1994 and 1994-1995 School Years

Presented to the
Alliance for Education

March 7, 1996

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EXECUTIVE SUMMARY

Artificial intelligence based software programs have been developed by the US Air Force's Armstrong Laboratory to aid in teaching of the fundamental skills of writing and algebra word problem solving. These tutors have been field tested locally at Dayton Dunbar High School and Trotwood-Madison High School. The focus of this research was to determine the effect of tutor usage on student performance on the Ohio Proficiency Test (OPT).

Each of the tutors was addressed separately, and in each case the study population was limited to students who failed the math or writing portion of the OPT in the fall. The comparison of subscores between groups in the fall was then used to validate the statistical equivalence of the groups at the beginning of the school year. This does not, however, mean that the OPT is a valid test to measure student learning with the tutors.

There was a lack of any statistical significance in the passing rate on the OPT of the students who used the word problem solving tutor over those who did not, indicating that the software was not effective at helping students pass this important exam. There was, however, a significant improvement in passing rate for students who did not use the tutor in the Workshop classes at Trotwood-Madison over students in Workshop classes which did use the tutor. This could suggest that the tutor was not an appropriate teaching aid for this group of students. It could also, however, simply be a reflection of the inability of OPT data to reflect learning accomplished through the use of the tutor.

Comparison of the subscores for the students who did and did not use the tutor suggested that the only area which showed an improvement of the tutor group over the control population was in the one area not believed to be addressed by the tutor (Data Analysis). These results further substantiate the suggestion that the word problem solving tutor is not an effective teaching aid of the material covered in the Ohio Proficiency Test.

Conversely, the results for the writing tutor were much more promising. There was a significant increase in the passing rate for the students who used the writing tutor over those who did not. This strongly indicates that the writing tutor software was highly effective at helping students pass this important exam.

Comparison of the subscores for the groups shows that the tutor group was able to improve their relative score from the lowest to the highest in the area of Content Organization. Likewise, the tutor group was able to at least remain equivalent to the other groups in the other subscore areas. The greatest help appears to be in the area of Content Organization which is the area most strongly addressed by the tutor.

Of course, other factors not controlled by the researchers can always affect the observed results. The fact that a large percentage of the control population came from another school may be a cause for concern. Likewise, differences in school curriculums, student populations, teacher experience and style, and mid-year updates of the tutors themselves could all play a part in affecting the results.

All of this analysis must be considered with the understanding that the Ohio Proficiency Test was not designed to be used as a measure of instructional techniques. In addition, a number of variables were not controlled in this comparison and could have had a significant impact on the results and conclusions. Furthermore, both tutors address a variety of material not evaluated by the OPT which could be of value to the students.

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1.0 BACKGROUND

Several artificial intelligence-based software tutoring programs have been developed by the US Air Force's Armstrong Laboratory to aid in teaching the fundamental skills of writing (R-WISE), science (ISIS), and algebra word problem solving (WPS). Each of these tutors has been field tested at Dayton Dunbar High School and Trotwood-Madison High School as well as several other sites across the nation. The design of the R-WISE and WPS tutors suggests they may help students increase scores and pass the Ohio Proficiency Test (OPT). Through correlation of student usage of the tutor with OPT results, local researchers hoped to determine if the tutors were indeed an advantageous tool for preparation for this important exam. However, it should be noted that the tutors and Ohio Proficiency Test were not designed for use together. A lack of an improvement in OPT scores does not necessarily indicate that the students did not learn as a result of using the tutor, it could simply mean that the OPT is not the appropriate method of measurement for the effects of the tutors.

2.0 THE WORD PROBLEM SOLVING TUTOR/OPT ANALYSIS

This analysis includes data collected from Dayton Dunbar High School and Trotwood-Madison High School during the 1993-1994 and 1994-1995 school years.

2.1 THE WORD PROBLEM SOLVING TUTOR

The WPS tutor is divided into a series of modules which address various topics. These modules were designed to be appropriate for the class materials covered in a general 9th grade Algebra course.

2.2 THE MATH SECTION OF THE OPT

The Ohio Department of Education has established a series of strands and learning outcomes which the math section of the Ohio Proficiency Test has been designed to measure. These strands and learning outcomes are listed in Table 1 and identified as to whether there are WPS tutor modules which address similar topics. Additional information about the mathematics learning outcomes is available in information published by the Ohio Department of Education.

Examples of test results from the math section of the Ohio Proficiency Test are given in Table 2. Each section of the Ohio Proficiency Test is scored on three levels. The first level is a pass/fail marking. A student who passes the test is not given any further scoring (i.e. score or subscores are omitted), and only a passing mark is returned to the school. A student who fails the math section of the test is then given a general score which can range from 0 to 199 given to three significant figures (i.e. 176, 180,...). The student is then given a subscore ranking in each of the five following strand areas: Arithmetic, Measurement, Geometry, Data Analysis, and Algebra. The possible subscore rankings are +, *, or – as defined in Table 2.

Through analysis of the goals and directives of the WPS tutor and the Ohio Proficiency Test, it was determined by the researchers that the WPS tutor did not directly address the issues evaluated in the Data Analysis subscore area. Therefore, the tutor would not be expected to increase student performance in this area. The other areas, however, were believed to be addressed by the tutor and should be affected by tutor usage.

2.3 STUDY POPULATIONS

The study population included only those students who failed the math section of the Ohio Proficiency Test in the fall of the year of study and for whom data was available for the spring test of that same year. Data were collected for the 1993-1994 school year and the 1994-1995 school year. The sample size for each population group and year are given in Table 3.

Table 1: WPS tutor modules and OPT mathematics strands.

OPT MATHEMATICS. STRANDS	FOCUS OF WPS TUTOR
Arithmetic	
1. Compute with whole numbers, fractions, and decimals	1. Yes
2. Compare, order, and determine equivalence of fractions, decimals, percents, whole numbers, and integers	2. No
3. Solve and use proportions	3. Yes
4. Round numbers to the nearest thousand, hundred, ten, one, tenth, and hundredth	4. Yes
5. Solve problems and make applications involving percentages	5. Yes
Measurement	
6. Select and compute with appropriate standard or metric units to measure length, area, volume, angles, weight, capacity, time, temperature, and money	6. No
7. Convert, compare, and compute with common units of measure within the same measurement system	7. Yes
8. Read the scale on a measurement device to the nearest mark and make interpolations where appropriate	8. No
Geometry	
9. Recognize, classify, and use characteristics of lines and simple two-dimensional figures	9. No
10. Find the perimeters (circumference) and areas of polygons (circles)	10. Yes
11. Find surface areas and volumes of rectangular solids	11. Yes
Data Analysis	
12. Read, interpret, and use tables, charts, maps, and graphics to identify patterns, note trends, and draw conclusions	12. No
13. Use elementary notions of probability	13. No
14. Compute averages	14. No
Algebra	
15. Solve simple number sentences and use formulas	15. Yes
16. Evaluate algebraic expressions (simple substitutions)	16. Yes

Table 2: Sample results for the math section of the Ohio Proficiency Test.

NAME	PASS or FAIL	SCORE	MEASURE-MENT	ARITH-METIC	GEOM-ETRY	DATA ANALYSIS	ALGE-BRA
Larry Student	Pass						
Mary Student	Fail	182	+	–	–	*	–
Carry Student	Fail	176	–	–	–	+	*
Berry Student	Fail	196	+	+	–	*	*

– = Performance lower than expected of students at the standard

* = Performance approximately the same as expected of students at the standard

+ = Performance higher than expected of students at the standard

Table 3: Number of students included in the WPS data analysis for each group and year.

	WPS			Control			Total
	Dunbar Algebra	T-M Algebra	T-M Workshop	Dunbar Algebra	T-M Algebra	T-M Workshop	
93-94 School Year	82	55	20	33	0	0	190
94-95 School Year	38	37	72	103	53	52	355
School Total	120	92	92	136	53	52	
Group Total	212		92	189		52	545

2.3.1 CONTROL

The control population included students who were enrolled in an algebra class which did not use the Air Force-developed software designed to enhance word problem solving proficiency. During the first year of the study, no control population was available at Trotwood-Madison High School. Therefore, for data comparison, the control group from Dunbar High School was used if needed. Regardless, the control population would include students who were operating at class level, above class level, and below class level. For the purposes of this study, the control population was assumed to be equivalent to the treatment population. The accuracy of this assumption can be validated by comparison of fall scores and subscores on the Ohio Proficiency Test. This assumption is further validated by the fact that the study population was limited to students who failed the math portion of the Ohio Proficiency Test during the fall of the year in question.

2.3.2 WPS

The WPS population included students from Dunbar and Trotwood-Madison High Schools who were enrolled in an algebra class which used the WPS tutor. This group represents the experimental population in this study.

2.4 DATA ANALYSIS

In all cases, a Chi-Square analysis with a confidence interval of 5% was used to determine the statistical significance of the data. This indicates that if the numbers are statistically significant, then there is at least a 95% certainty that the same statistics would be observed in other, equivalent, populations. Tabular representations of all of the data presented are included in Appendix A1.

For this analysis all of the treatment groups (Dunbar Algebra I Part I, Trotwood Practical Algebra, and Trotwood Workshop) were combined into one large treatment group, and likewise their representative control groups were combined into one large control group. This gave the largest sample size possible and should provide the most accurate statistics.

Combining the groups should also show the effectiveness of using the tutor in general, with less affect arising from school curriculum differences, teacher styles, and class structure differences.

2.4.1 COMPARISON OF DATA BETWEEN YEARS

Comparison of grouped results by the year of study allows for validation of the equivalence of the study populations each year. If the study populations are equivalent, then it is statistically valid to combine the data from each year into one larger sample set. This then increases the statistical significance of further data analysis. If the groups are not statistically equivalent across years, the data can still be combined. However, this could lead to a greater spread in the data when comparisons are made between treatment and control groups and could enhance the likelihood of insignificant results.

2.4.1.1 FALL

2.4.1.1.1 PASS/FAIL ANALYSIS

Due to that fact that the study population was limited to students who failed the OPT in the fall, no comparison can be made in this area.

2.4.1.1.2 SCORE ANALYSIS

Due to the nearly continuous spread in the scores for the math section of the OPT, this analysis is complex and is not available at this time.

2.4.1.1.3 SUBSCORE ANALYSIS

Comparison of fall subscores between years does not show any significant difference between year populations in any of the subscore categories except Geometry. These data indicate that the 1993-1994 students had a higher competency level in Geometry than the 1994-1995 students at the beginning of the school year. This finding was significant and

appeared again when the same comparison was made, with the exclusion of the Workshop students. The fact that all other subscore categories showed no significance supports combination of the data by year. However, the significance of the Geometry results should not be ignored.

2.4.1.2 SPRING

2.4.1.2.1 PASS/FAIL ANALYSIS

Using a Chi-Square analysis to compare pass/fail rates for the spring test between the 1993-1994 and 1994-1995 school years showed no significant difference between year populations. These data substantiate the validity of combining the data from these two years of study into one data group to enlarge the sample size. This then enhances the statistical validity of additional data analysis.

2.4.1.2.2 SCORE ANALYSIS

Due to the nearly continuous spread in the scores for the math section of the OPT, this analysis is complex and is not available at this time.

2.4.1.2.3 SUBSCORE ANALYSIS

Comparison of spring subscores between years showed that the populations were not statistically equivalent in the areas of Arithmetic, Data Analysis, or Algebra (Figure 1). However, they were statistically equivalent in the areas of Measurement and Geometry. During the second year of the study, student subscores in the areas of Arithmetic and Algebra increased significantly over the first year of the study, while students in the first year performed significantly better in the spring in the area of Data Analysis than did the students in the second year. The area of Data Analysis is not believed to be addressed by the tutor. Therefore, any increase in student scores should be attributed to an uncontrolled variable, or may suggest that the OPT is not a good measure of student achievement as it relates to the WPS tutor. In addition, other factors such as class variations, curriculum modifications, teachers reassignments, and time-on-task must also be considered.

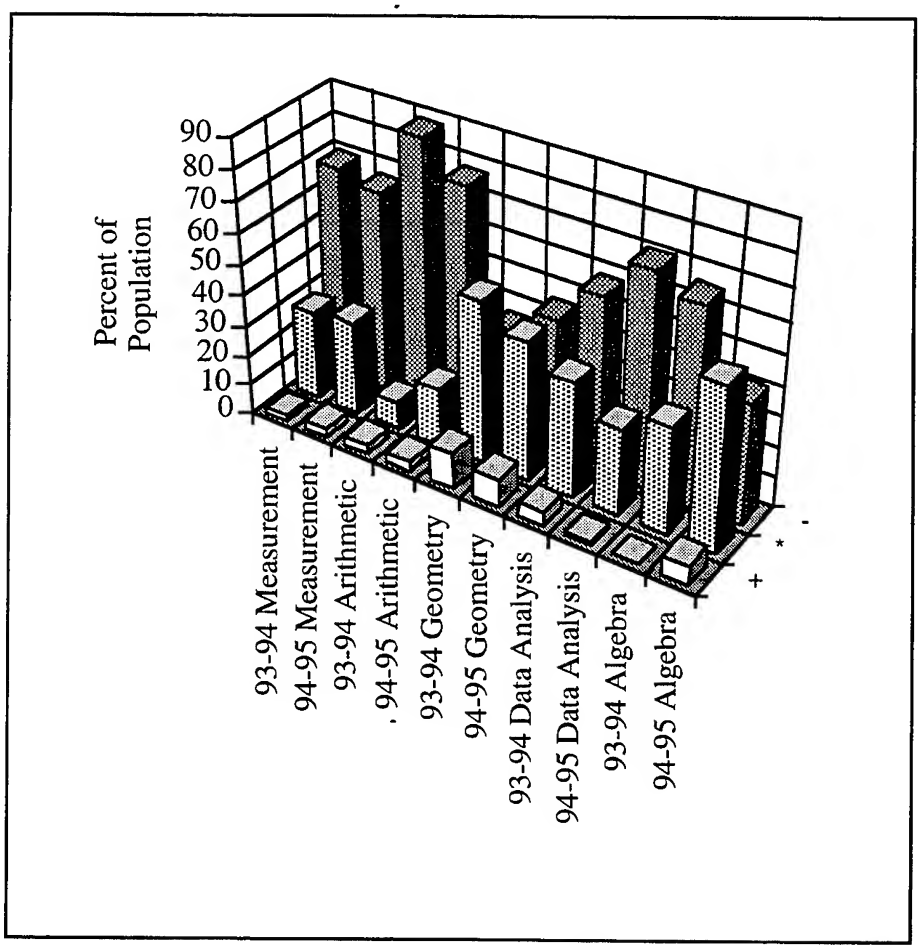

Figure 1: Spring subscore analysis by year of observation for WPS analysis. Subscore rankings are: performed lower than expected for students at the standard (–), performed approximately the same as expected of students at the standard (*), or performed higher than expected of students at the standard (+).

2.4.2 COMPARISON OF DATA BETWEEN GROUPS

All of the preceding analysis suggested the students are generally statistically equivalent in the 1993-1994 and 1994-1995 school years. It says nothing, however, about the equivalence of the groups. By combining the data according to group, regardless of the

year of study, a comparison can be made between the groups. This, then, can be used to determine the effectiveness of the tutor.

2.4.2.1 FALL

2.4.2.1.1 PASS/FAIL ANALYSIS

Due to the fact that the study population was limited to students who failed the OPT in the fall, no comparison can be made in this area.

2.4.2.1.2 SCORE ANALYSIS

Due to the nearly continuous spread in the scores for the math section of the OPT, this analysis is complex and is not available at this time.

2.4.2.1.3 SUBSCORE ANALYSIS

Chi-Squared analysis of fall subscores showed no statistically significant variance in the groups. This indicates that the treatment and control groups were statistically equivalent at the beginning of the year. This enhances the validity of our comparison between these two groups.

2.4.2.2 SPRING

2.4.2.2.1 PASS/FAIL ANALYSIS

This measure of the data gives the clearest representation of the effectiveness of the tutor at helping students pass the OPT. The goal of each student is to pass the test. An increase in score may suggest an increase in ability, but without passing the test the students and schools do not measure any great improvement. Figure 2 displays the percentage of students in the treatment and control groups passing the test during the spring of the year of study. These differences were <u>not</u> statistically significant.

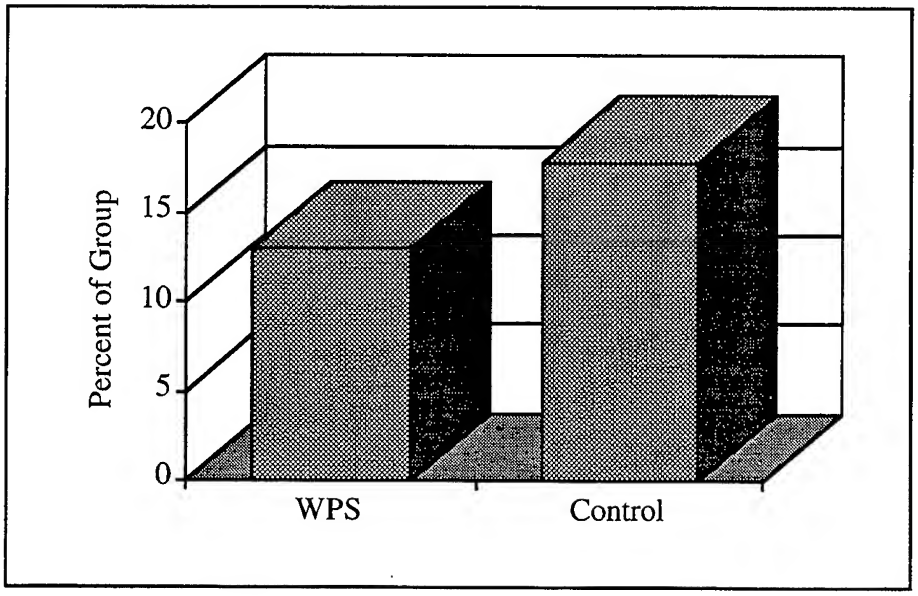

Figure 2: Passing percent by group for WPS analysis. The difference between the groups is not statistically significant.

This suggests that use of the WPS tutor had no affect on student passing rates for the math section of the OPT. The lack of a difference in the passing rates could easily be attributed to other variables such as teacher differences, school curriculum variations, student population differences, and other non-controlled variables.

Similar comparisons were also made for each of the schools and courses independently. These comparisons again showed a lack of significance with the exception of the Trotwood-Madison Workshop classes. The results for this course were statistically significant and are shown in Figure 3. These results suggest that the tutor may have lowered the chances of the students being able to pass the OPT. This could be a result of loss of class time due to use of the tutor, if indeed the tutor does not help. However, this could also simply be a result of other differences between the treatment and control populations and could have no basis in tutor usage at all. Since this is a localized result, and not strongly supported by additional statistics in the subscore analysis, it should be viewed with caution.

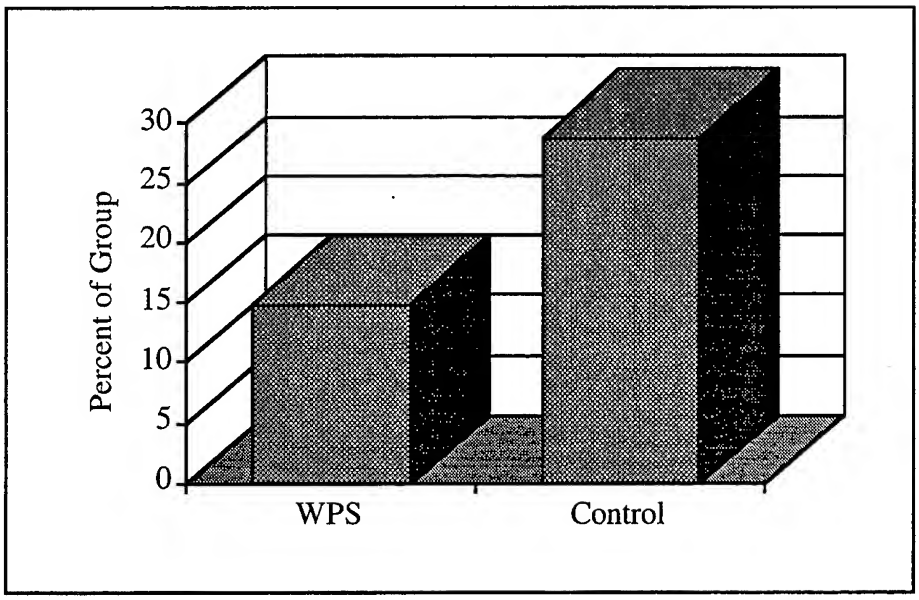

Figure 3: Passing percent for the Trotwood-Madison Workshop classes.

2.4.2.2.2 SCORE ANALYSIS

Due to the nearly continuous spread in the scores for the math section of the OPT, this analysis is complex and is not available at this time.

2.4.2.2.3 SUBSCORE ANALYSIS

The Chi-Squared analysis of spring subscores showed a statistically significant variance in the subscore categories of Data Analysis and Algebra (Figure 4). The other subscore categories did not show any significant difference between the treatment and the control populations. The area of Data Analysis was not believed to be addressed by the tutor. However, students who used the tutor appeared to do better in this subscore area. This could indicate that either the initial tutor goals were not properly identified, or the OPT is measuring another difference between the study populations. The control population appeared to perform better in the area of Algebra which should have been addressed by the tutor. This again suggests that either the tutor is not effective, or the OPT is not a good measure of the effect of the tutor.

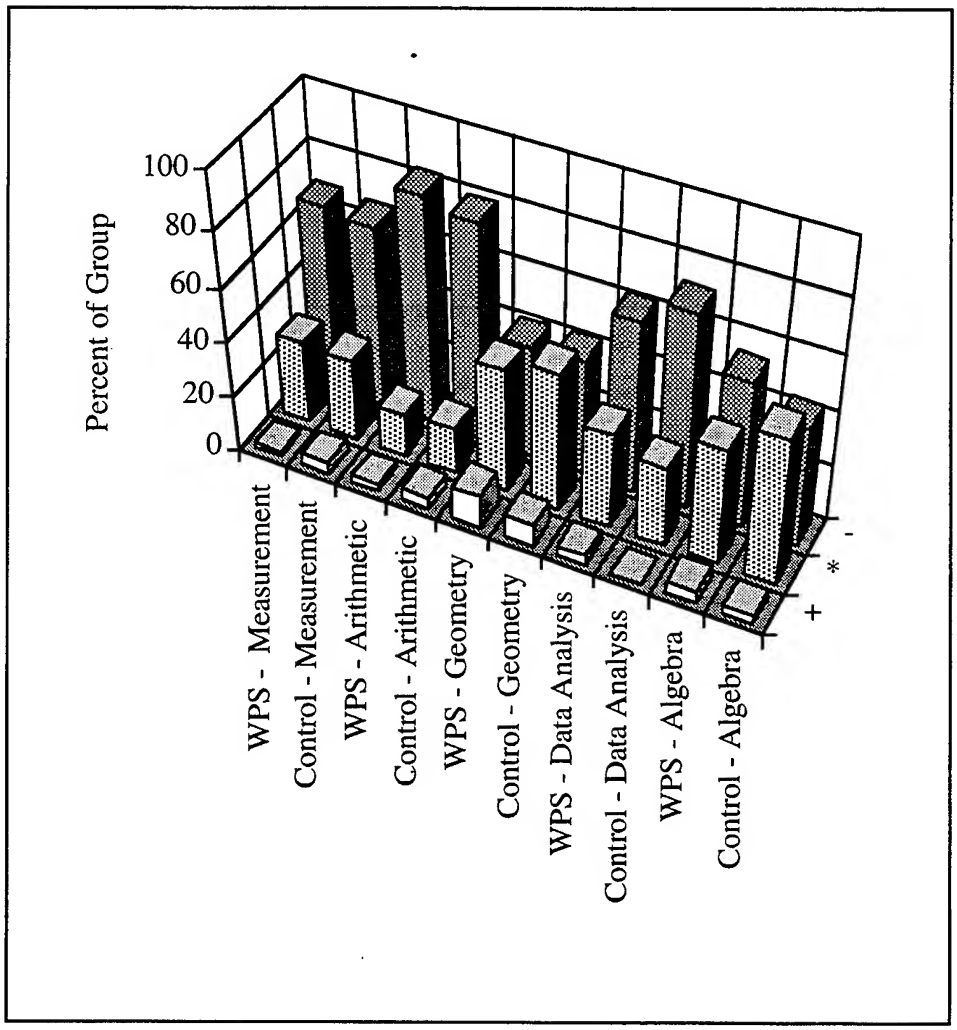

Figure 4: Spring subscore by group for WPS analysis. Subscore rankings are: performed lower than expected for students at the standard (–), performed approximately the same as expected of students at the standard (*), or performed higher than expected of students at the standard (+).

2.5 RESULTS OF WPS TUTOR ANALYSIS

Although a lot of data were collected and analyzed, the most relevant question to be answered relates to the effectiveness of use of the tutor to aid students with passing the OPT. The fact that the study population was limited to students who failed the math portion of the OPT in the fall, and that the comparison of subscores between groups in the

fall suggest that the groups were statistically equivalent at the beginning of the school year, suggest that this statistical comparison between students who did and did not use the tutor should be valid. It does not, however, mean that the OPT is a valid test to measure student learning with FST. It will simply be an indication of whether students who used the tutor performed better on the OPT.

The lack of any statistical significance in the passing rate of the students who used the WPS tutor over those who did not indicates that the WPS software may not be effective at helping students pass this important exam. The significant improvement in passing rate for students who did not use the tutor in the Workshop classes at Trotwood-Madison over students in Workshop classes which did use the tutor could suggest that the tutor is not an appropriate teaching aid for this group of students. It could also, however, simply be a reflection of the inability of OPT data to reflect learning accomplished through the use of the tutor.

Comparison of the subscores for the groups (Table 4) suggests that the only area which showed an improvement of the WPS group over the control population was in the one area not believed to be addressed by the tutor (Data Analysis). These results further substantiate the suggestion that the WPS tutor is not an effective teaching aid of the materials covered in the Ohio Proficiency Test.

Table 4: Group which performed the best on a given area of the math section of the OPT.

	Fall Exam	Spring Exam
Arithmetic	Equivalent	Equivalent
Measurement	Equivalent	Equivalent
Geometry	Equivalent	Equivalent
Data Analysis	Equivalent	WPS
Algebra	Equivalent	Control

Of course, other factors not controlled by the researchers can always affect the observed results. Differences in school curriculums, student populations, teacher experience and style, and mid-year updates of the tutors themselves could all play a part by affecting the data analysis.

3.0 THE R-WISE TUTOR/OPT ANALYSIS

This analysis includes data collected from Dayton Dunbar High School, Dayton Belmont High School, and Trotwood-Madison High School during the 1993-1994 and 1994-1995 school years.

3.1 THE R-WISE TUTOR

The R-WISE tutor (Reading and Writing in a Supportive Environment) is divided into a series of tools which address various topics. Through observation and use of the tutor and analysis of some of the literature provided by Armstrong Laboratory on the objectives of the tutor, correlations were made between the writing characteristics and learning outcomes defined by the Ohio Department of Education for the OPT and the tutor itself. This comparison is shown in Table 5.

3.2 THE WRITING SECTION OF THE OPT

The Ohio Department of Education has established a series of characteristics and learning outcomes which the writing section of the Ohio Proficiency Test has been designed to measure. Table 5 lists the writing characteristics and related learning outcomes as defined by the Ohio Department of Education.

Examples of possible test results from the writing section of the Ohio Proficiency Test are given in Table 6. The writing section of the OPT is scored on three levels. The first level is a pass/fail marking. A student who passes the test is not given any further scoring (i.e. score or subscores are omitted), and only a passing mark is returned to the school. A student who fails the writing section of the test is then given a general score which can range from 0 to 4.5 given in two significant figures (i.e. 3.5, 4.0,...). The student is then given a subscore ranking in each of the three following characteristic areas: Content/Organization, Language, and Writing Conventions. The possible subscore rankings are: satisfactory, needs some help, or needs help.

Table 5: OPT writing characteristics and R-WISE tutor objectives.

OPT WRITING CHARACTERISTICS	FOCUS OF R-WISE TUTOR
Content/Organization	
1. Conveys a message related to the prompt	1. Yes
2. Includes supporting ideas or examples	2. Yes
3. Follows a logical order	3. Yes
4. Conveys a sense of completeness	4. Yes
Language	
5. Exhibits word choice appropriate to the audience, purpose, and subject	5. Yes
6. Includes clear language	6. No
Writing Conventions	
7. Contains complete sentences and may contain purposeful fragments	7. No
8. Exhibits subject-verb agreement	8. No
9. Contains standard forms of verbs and nouns	9. No
10. Exhibits appropriate punctuation	10. No
11. Exhibits appropriate capitalization	11. No
12. Contains correct spelling	12. No
13. Is legible	13. No

Table 6: Sample results for the writing section of the Ohio Proficiency Test.

NAME	PASS or FAIL	SCORE	ORGANIZATION	LANGUAGE	WRITING CONVENTIONS
Larry Student	Pass				
Mary Student	Fail	4.0	NH	NSH	S
Carry Student	Fail	3.5	NSH	NH	NH
Berry Student	Fail	4.5	NH	NH	S

S = Satisfactory
NSH = Needs Some Help
NH = Needs Help

Through analysis of the goals and directives of the R-WISE tutor and the Ohio Proficiency Test, it was determined by the researchers that the R-WISE tutor did not directly address the issues evaluated in the Writing Conventions subscore area. Therefore, the tutor would not be expected to increase student performance in this area. The other areas, however, were believed to be addressed by the tutor and should be affected by tutor usage.

3.3 STUDY POPULATIONS

The study population included only those students who failed the writing section of the Ohio Proficiency Test in the fall of the year of study and for whom data were available for the spring test of that same year. Data were collected for the 1993-1994 school year and the 1994-1995 school year. The sample size for each population group and year are given in Table 7.

Table 7: Number of students included in data analysis for each group and year for R-WISE analysis.

	R-WISE Dunbar	R-WISE T-M	WRITE Dunbar	WRITE T-M	Control Belmont	Control T-M	Total
93-94 School Year	25	44	19	12	53	42	195
94-95 School Year	36	111	0	0	77	0	224
School Total	61	155	19	12	130	42	
Group Total	216		31		172		419

3.3.1 CONTROL

The control population included students who were not exposed to any Air Force-developed software designed to enhance writing proficiency. The majority of this population were students in the ninth grade at Belmont High School. However, some students in the control population were ninth grade students at Trotwood-Madison High School during the 93-94 school year who were not enrolled in a ninth grade English class which used the tutor. Because class rosters were not always available for classes which did not use the tutor, the remaining 9th grade population was used. As a result, students who were enrolled in a class other than a standard 9th grade English class would be included in this population group. This could include students who were in honors level or remedial level courses. In either case, the control population would include students who were operating at class level, above class level, and below class level. For the purposes of this study, the control population was assumed to be equivalent to the treatment population. The accuracy of this assumption can be validated by comparison of fall scores and subscores on the Ohio Proficiency Test. This assumption is further validated by the fact

that the study population was limited to students who failed the writing portion of the Ohio Proficiency Test during the fall of the year in question.

3.3.2 WRITE

The WRITE population included students from Dunbar and Trotwood-Madison High Schools who were enrolled in a standard 9th grade English class which used a simple word processor to assist in writing. The software did not contain any of the tutor assistance available in the more advanced version of the tutor. This group was used to study the effect of technology usage alone compared to the use of the more advanced tutor.

3.3.3 R-WISE

The R-WISE population included students from Dunbar and Trotwood-Madison High Schools who were enrolled in a standard 9th grade English class which used the advanced R-WISE tutor. This group represents the true experimental population in this study.

3.4 DATA ANALYSIS

In all cases, a Chi-Square analysis with a confidence interval of 5% was used to determine the statistical significance of the data. This indicates that if the numbers are statistically significant, then there is at least a 95% certainty that the same statistics would be observed in other, equivalent, populations. Tabular representations of all of the data presented are included in Appendix A1.

3.4.1 COMPARISON OF DATA BETWEEN YEARS

Comparison of grouped results by the year of study allows for validation of the equivalence of the study populations each year. If the study populations are equivalent, then it is statistically valid to combine the data from each year into one larger sample set. This then increases the statistical significance of further data analysis. If the groups are not statistically equivalent across years, the data can still be combined. However, this could

lead to a greater spread in the data when comparisons are made between treatment and control groups and could enhance the likelihood of insignificant results.

3.4.1.1 FALL

3.4.1.1.1 PASS/FAIL ANALYSIS

Due to the fact that the study population was limited to students who failed the OPT in the fall, no comparison can be made in this area.

3.4.1.1.2 SCORE ANALYSIS

Comparison of the fall scores by year is graphed in Figure 5. These data shows that the students scored significantly different in the second year of the study from the first year on the writing section of the OPT (see Figure 5). These data suggest that the students performed better initially during the second year of the study than in the first.

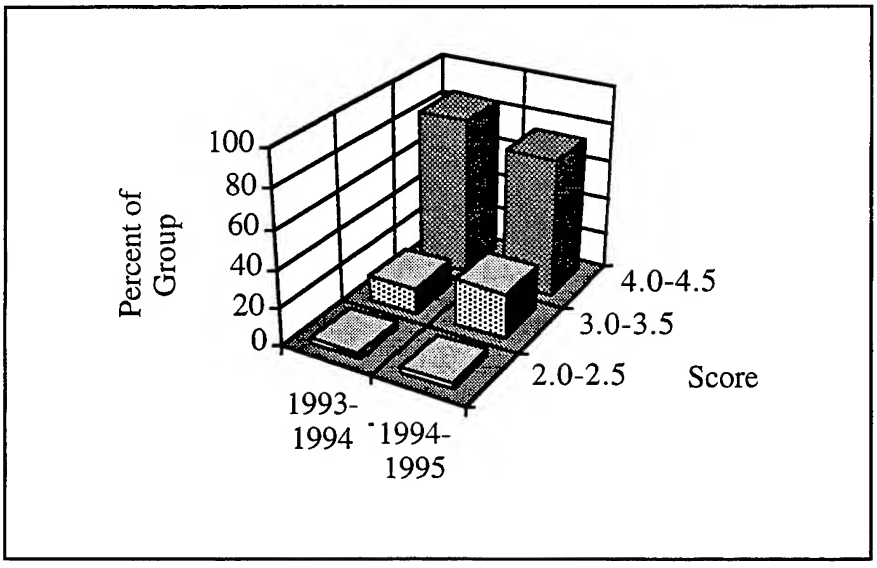

Figure 5: Student fall scores as a function of the year of the study for R-WISE analysis.

3.4.1.1.3 SUBSCORE ANALYSIS

Comparison of fall subscores between years did not show any significant difference between year populations in any of the subscore categories.

3.4.1.2 SPRING

3.4.1.2.1 PASS/FAIL ANALYSIS

Using a Chi-Square analysis to compare pass/fail rates for the spring test between the 1993-1994 and 1994-1995 school years showed no significant difference between year populations. These data substantiate the validity of combining the data from these two years of study into one data group to enlarge the sample size. This then enhances the statistical validity of additional data analysis.

3.4.1.2.2 SCORE ANALYSIS

Comparison of student scores in the spring as a function of the year of the study showed no statistical difference between years. Therefore, although the 94-95 class appeared to perform better in the score analysis performed for the fall test, they were statistically equivalent to the 93-94 class in the spring. Since each year contained both students who used the tutor and those who did not, this does not necessary reflect on tutor usage.

3.4.1.2.3 SUBSCORE ANALYSIS

Comparison of spring subscores between years showed that the populations were not statistically equivalent in the areas of Content Organization and Language (Figure 6). However, they are statistically equivalent in the area of Writing Convention which was not addressed by the tutor. During the second year of the study, student subscores in the area of Content Organization and Language increased significantly over the first year of the

study. The fact that this increase was seen only in those areas addressed by the tutor and not in the area not addressed by the tutor suggests that it may be related to tutor usage.

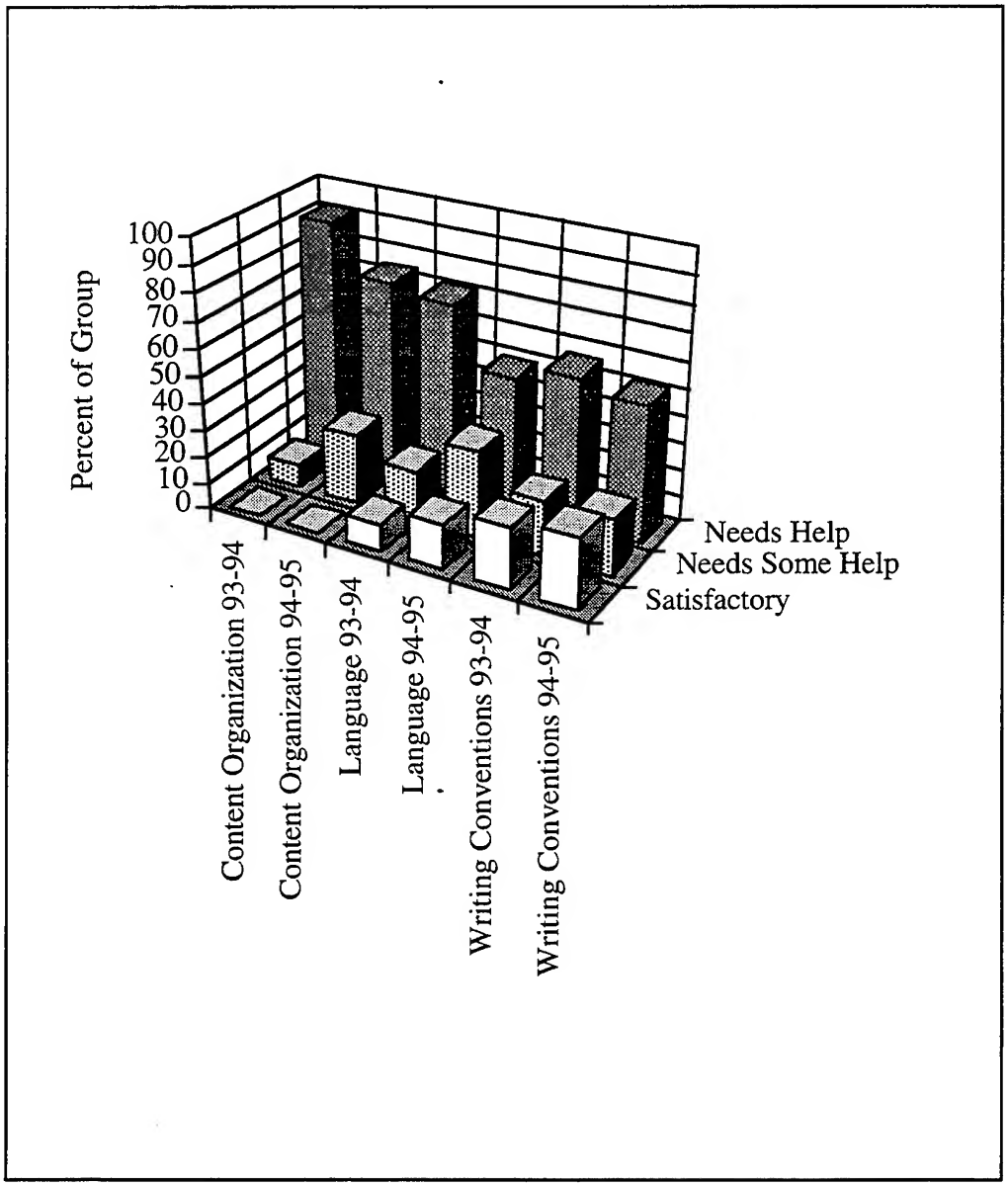

Figure 6: Spring subscore analysis by year of observation for the R-WISE analysis.

The greater effectiveness of the tutor during the second year could be a result of software upgrades or greater teacher comfort, and therefore, more effective teaching. Care must be

taken, however, in drawing conclusions from this comparison. The ratio of the number of students in the control and treatment populations was not the same for the two years. During the 1993-1994 school year, 42% of the sample was from the control population. However, during the 1994-1995 school year, only 34% of the sample was from the control population. If it is assumed that the tutor helps students improve their subscores, then the larger percentage of students exposed to the tutor during the second year of the study would give this group an effective higher score. Of course, other factors such as class variations, curriculum modifications, teachers reassignments, and time-on-task should also be considered.

3.4.2 COMPARISON OF DATA BETWEEN GROUPS

All of the preceding analysis suggests the students are generally statistically equivalent in the 1993-1994 and 1994-1995 school years. It says nothing, however, about the equivalence of the groups. By combining the data according to group, regardless of the year of study, a comparison can be made between the groups. This, then, can be used to determine the effectiveness of the tutor.

3.4.2.1 FALL

3.4.2.1.1 PASS/FAIL ANALYSIS

Due to the fact that the study population was limited to students who failed the OPT in the fall, no comparison can be made in this area.

3.4.2.1.2 SCORE ANALYSIS

The Chi-Squared analysis of fall scores showed a statistically significant variance in the data; observation of Figure 7 shows that the WRITE group performed the best, followed by the R-WISE and control groups.

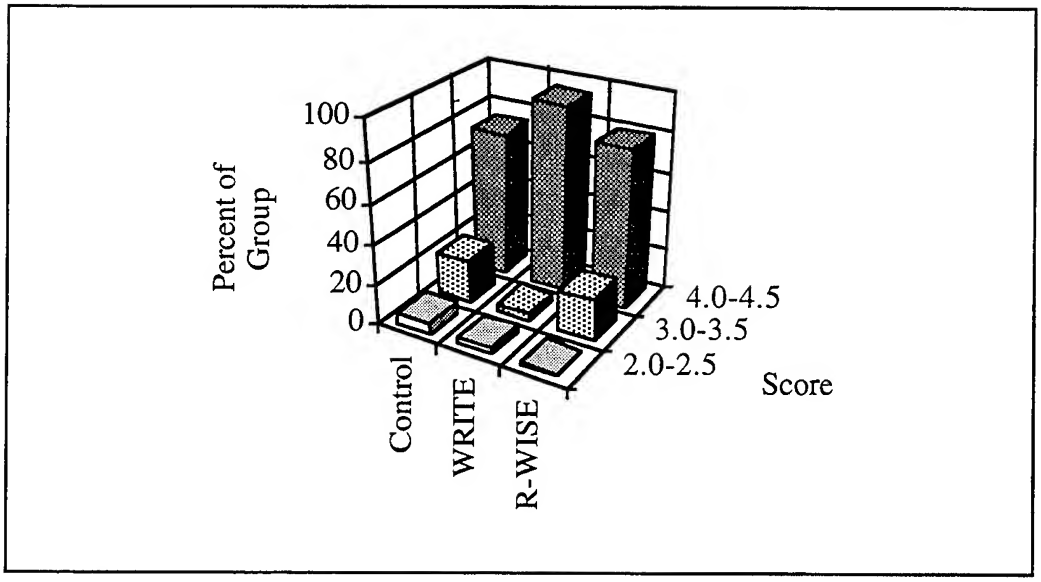

Figure 7: Fall score by group for R-WISE analysis.

3.4.2.1.3 SUBSCORE ANALYSIS

Comparison of the fall subscores between groups showed that the groups were not statistically equivalent in the areas of Content Organization and Writing Conventions (See Figure 8). They were, however, statistically equivalent in the area of Language.

In the area of Writing Conventions the R-WISE group appeared to perform the best, while in the area of Content Organization the R-WISE group appeared to perform the worst. This information should be kept in mind when analyzing the spring results after the R-WISE group has been exposed to the tutor.

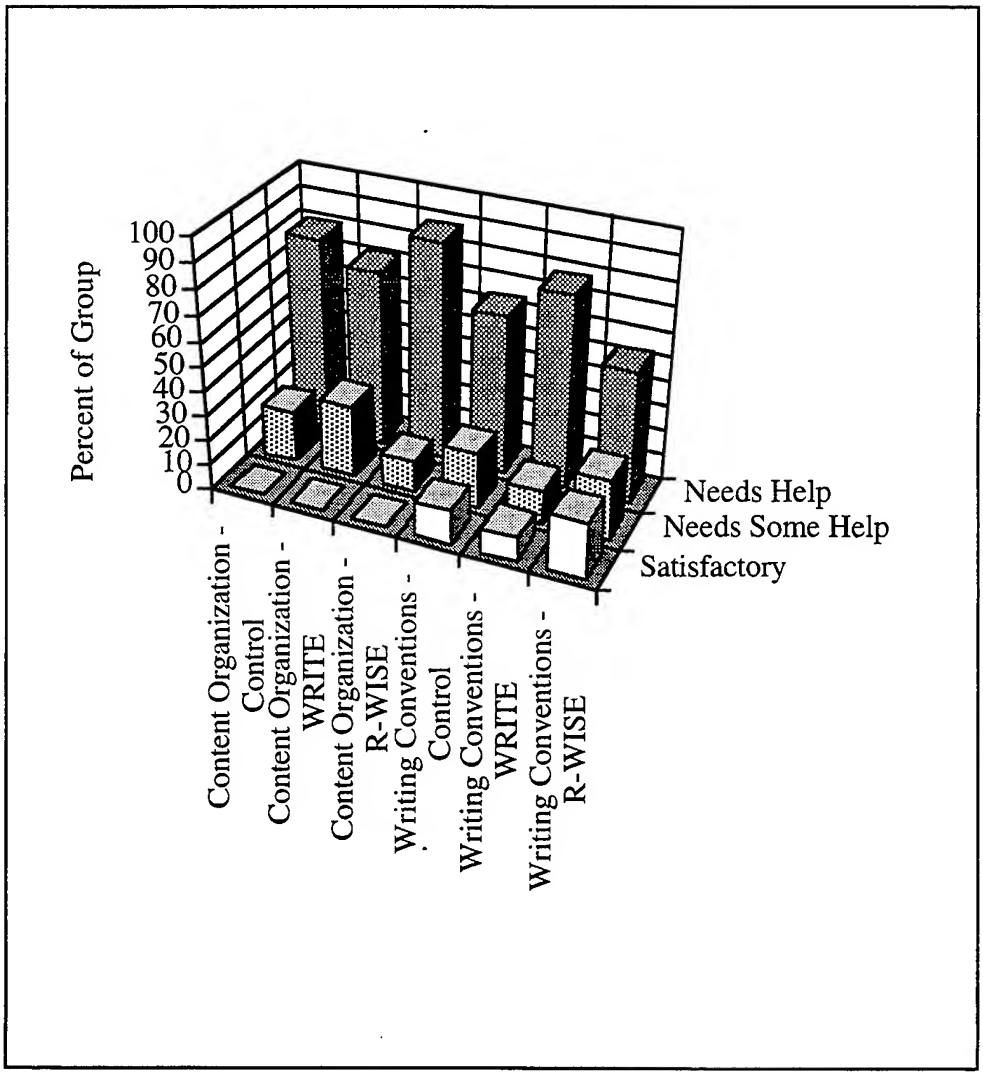

Figure 8: Fall subscore by group for R-WISE analysis.

3.4.2.2 SPRING

3.4.2.2.1 PASS/FAIL ANALYSIS

This measure of the data gives the clearest representation of the effectiveness of the tutor at helping students pass the OPT. The goal of each student is to pass the test. An increase in score may suggest an increase in ability, but without passing the test the students and schools do not measure any great improvement. Figure 9 displays the percentage of students in each group passing the test during the spring of the year of study. These

differences are highly statistically significant (Chi-Squared confidence level of 0.014) and may represent an improvement as a result of exposure to the R-WISE tutor.

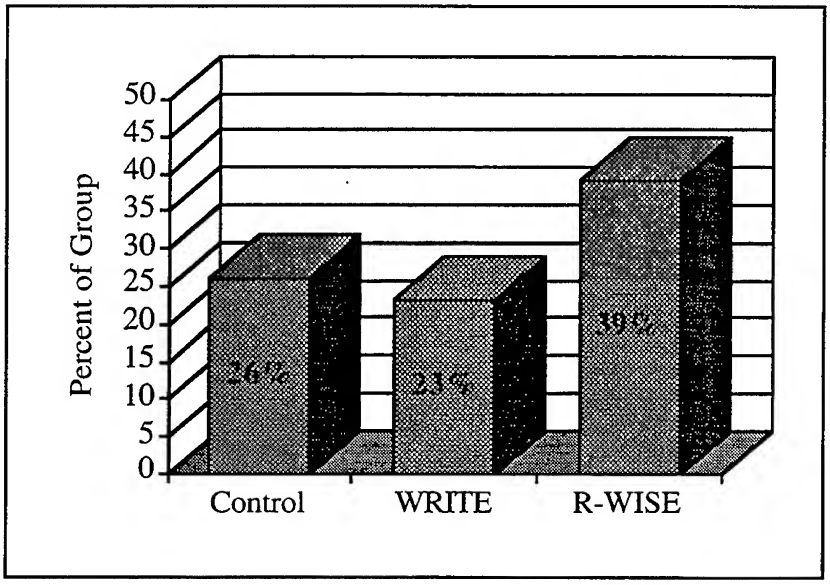

Figure 9: Passing percent by group for R-WISE analysis.

The increase in the passing rate for the Control group over the WRITE group suggests that time spent in the computer lab and away from other organized learning activities may have been detrimental to the students. There is a significant increase, however, measured as a result of the features present in the R-WISE version of the software. Again, care must be taken in comparison of the data, particularly in the situation of the Control group and the WRITE group. The difference in the passing rates is small and could easily be attributed to other variables such as teacher differences, school curriculum variations, student population differences, and other non-controlled variables.

3.4.2.2.2 SCORE ANALYSIS

The Chi-Squared analysis of spring scores showed a statistically significant variance in the data; observation of Figure 10 shows that the WRITE and R-WISE groups performed at about the same level and were followed by the control group.

In both the fall and spring analysis, the WRITE group appeared to perform the best. This indicates that the group started the year with a higher level of proficiency and ended the year in the same position. The R-WISE group was notably below the WRITE group in the fall analysis, but appears to be almost equivalent in the spring analysis. This suggests that the R-WISE group was able to significantly increase their relative scores on the exam after exposure to the tutor.

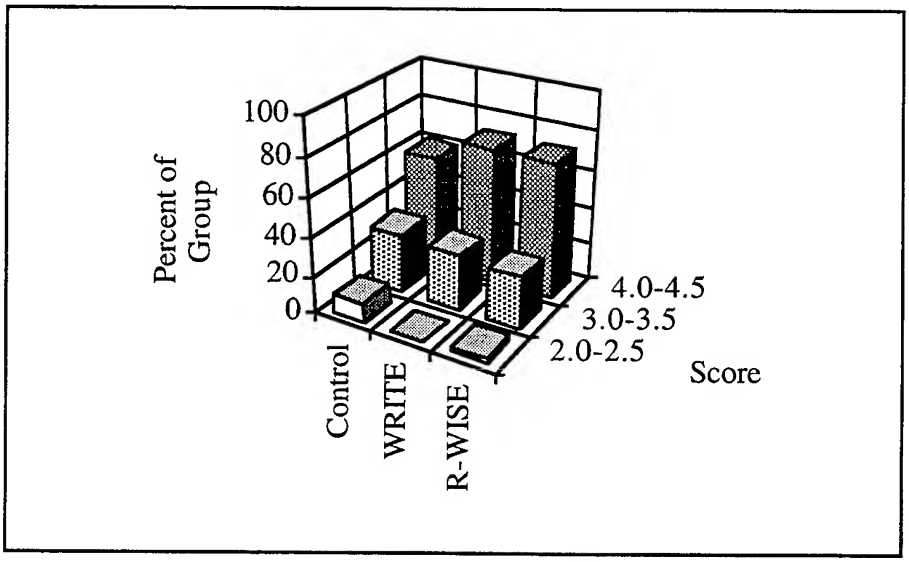

Figure 10: Spring score by group for R-WISE analysis.

It should also be noted that comparison of Figure 7 with Figure 10 shows an overall decrease in student scores within each group between the fall and spring testing dates. This is probably more of a reflection of the way the test is scored than of the students' performance. Students who improved their score enough to pass the test are not given a score or subscore in the spring. Therefore, they are absent from the spring analysis which is reflected in an overall lowering of the scores.

3.4.2.2.3 SUBSCORE ANALYSIS

Comparison of spring subscores by group showed statistical significance only in the area of Content Organization (see Figure 11).

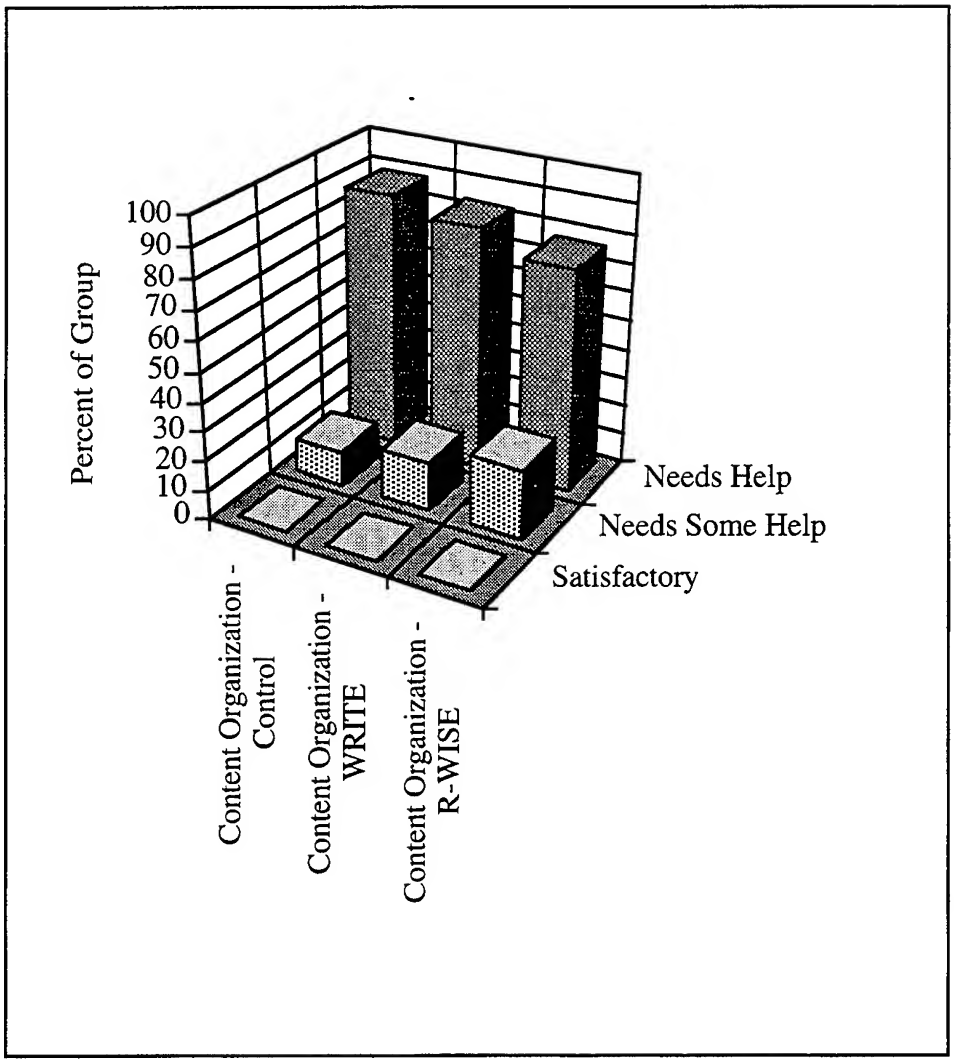

Figure 11: Spring subscore by group for R-WISE analysis.

In the fall subscore comparison of these two groups, they were not statistically equivalent in the areas of Content Organization or Writing Conventions with the R-WISE group performing slightly better in the area of Writing Conventions and the control group performing slightly better in the area of Content Organization. After exposure of the R-WISE and WRITE groups to computer-based training, all the groups were statistically equivalent in the area of Writing Conventions. This area is not believed to be addressed by the tutor. Therefore, if the tutor is affecting scores, we would not expect it to affect them in

this area. This suggests that during regular classroom instruction, the control group and WRITE group improved more in this area than did the R-WISE group.

In the area of Content Organization, however, the control group initially performed better, while the R-WISE group performed better in the spring. This suggests that the students using the R-WISE tutor were able to improve their performance from significantly below the control group to significantly above them during the course of the year. This provides strong support for the ability of the R-WISE tutor to improve student performance on the OPT.

3.5 RESULTS OF R-WISE DATA ANALYSIS

Although a lot of data were collected and analyzed, the most relevant question to be answered relates to the effectiveness of use of the tutor to aid students with passing the OPT. The fact that the study population was limited to students who failed the writing portion of the OPT in the fall, and that the comparison of subscores between groups in the fall showed no significant difference between groups, suggests that the groups were statistically equivalent at the beginning of the school year. The increased passing rate of the students who used the R-WISE tutor over those who did not is significant. This strongly indicates that the R-WISE software may be highly effective at helping students pass this important exam.

Comparison of the subscores for the two groups (Table 8) shows that the R-WISE group was able to improve their relative score from the lowest of the three to the highest in the area of Content Organization. Likewise, the R-WISE group was able to at least remain equivalent to the other groups in the other subscore areas. The greatest help appears to be in the area of Content Organization which is the area most strongly addressed by the tutor.

Of course, other factors not controlled by the researchers can always affect the observed results. The fact that a large percentage of the control population came from another school may be a cause for concern. Likewise, differences in school curriculums, student populations, teacher experience and style, and mid-year updates of the tutors themselves could all play a part in affecting the data analysis.

However, the data collected to date suggest that the R-WISE software can increase the passing rate of students on the writing portion of the OPT by about 13%.

Table 8: Best and worst performers on a given area of the writing section of the OPT.

	Fall Exam		Spring Exam	
	Best Performer	Worst Performer	Best Performer	Worst Performer
Content Organization	WRITE	R-WISE	R-WISE	Control
Language	Equivalent		Equivalent	
Writing Conventions	R-WISE	WRITE	Equivalent	

4.0 CONCLUSIONS

This analysis suggests that the tutos must be considered individually as to their merit with respect to being able to increase student performance on the Ohio Proficiency Test. It appears that the Word Problem Solving tutor aimed at 9th grade algebra students does not increase student performance on this important exam. It may, indeed, hinder student performance by utilizing valuable class time which could be better spent in alternative instruction. However, the R-WISE tutor designed to aid 9th grade students with the processes involved in writing appears to enhance student performance on the writing section of the Ohio Proficiency Test. Student passing rates and subscores were significantly impacted by exposure to the tutor. The greatest effect was measured in the area of Content Organization.

All of this analysis must be considered with the understanding that the Ohio Proficiency Test was not designed to be used as a measure of FST instructional techniques. In addition, a number of variables were not controlled in this comparison and could have had a significant impact on the results and conclusions. Furthermore, both of the tutors address material which is not evaluated by the OPT and which may of value to the students.

5.0 APPENDICES

APPENDIX A1 - TABULATED DATA

1.0 WPS TUTOR

1.1 Comparison of Data by Year

1.1.1 Fall Subscore Data

Measurement

	1993-1994	1994-1995	Total
–	154	285	439
*	34	65	99
+	2	5	7
Total	190	355	545

Arithmetic

	1993-1994	1994-1995	Total
–	155	285	440
*	32	59	91
+	3	11	14
Total	190	355	545

Geometry

	1993-1994	1994-1995	Total
–	53	180	233
*	118	148	266
+	19	27	46
Total	190	355	545

Data Analysis

	1993-1994	1994-1995	Total
–	113	210	323
*	69	125	194
+	8	20	28
Total	190	355	545

Algebra

	1993-1994	1994-1995	Total
–	110	228	338
*	70	119	189
+	10	8	18
Total	190	355	545

1.1.2 Spring Pass/Fail Data

	1993-1994	1994-1995	Total
Pass	22	60	82
Fail	163	295	458
Total	185	355	540

1.1.3 Spring Subscore Data

Measurement

	1993-1994	1994-1995	Total
–	113	195	308
*	47	91	138
+	3	9	12
Total	163	295	458

Arithmetic

	1993-1994	1994-1995	Total
–	142	227	369
*	15	58	73
+	5	10	15
Total	162	295	457

Geometry

	1993-1994	1994-1995	Total
–	57	132	189
*	86	135	221
+	19	28	47
Total	162	295	457

Data Analysis

	1993-1994	1994-1995	Total
–	93	208	301
*	62	85	147
+	7	2	9
Total	162	295	457

Algebra

	1993-1994	1994-1995	Total
–	105	118	223
*	57	159	216
+	0	18	18
Total	162	296	457

1.2 Comparison of Data by Group

1.2.1 Fall Subscore Data

Measurement

	WPS	Control	Total
–	248	191	439
*	50	49	99
+	6	1	7
Total	304	241	545

Arithmetic

	WPS	Control	Total
–	248	192	440
*	47	44	91
+	9	5	14
Total	304	241	545

Geometry

	WPS	Control	Total
–	128	105	233
*	154	112	266
+	22	24	46
Total	304	241	545

Data Analysis

	WPS	Control	Total
–	183	140	323
*	105	89	194
+	16	12	28
Total	304	241	545

Algebra

	WPS	Control	Total
–	183	155	338
*	110	79	189
+	11	7	18
Total	304	241	545

1.2.2 Spring Pass/Fail Data

	WPS	Control	Total
Pass	39	43	82
Fail	260	198	458
Total	299	241	540

1.2.3 Spring Subscore Data

Measurement

	WPS	Control	Total
–	177	131	308
*	79	59	138
+	4	8	12
Total	260	198	458

Arithmetic

	WPS	Control	Total
–	213	156	369
*	40	33	73
+	6	9	15
Total	259	198	457

Geometry

	WPS	Control	Total
–	106	83	189
*	122	99	221
+	31	16	47
Total	249	198	457

Data Analysis

	WPS	Control	Total
–	160	141	301
*	90	57	147
+	9	0	9
Total	259	198	457

Algebra

	WPS	Control	Total
–	137	86	223
*	110	106	216
+	12	6	18
Total	259	198	457

2.0 R-WISE TUTOR

2.1 Comparison of Data by Year

2.1.1 Fall Score Data

	1993-1994	1994-1995	Total
2	6	7	13
3	26	54	80
4	163	163	326
Total	195	224	419

2.1.2 Fall Subscore Data

Content Organization

	1993-1994	1994-1995	Total
NH	161	188	349
NSH	34	36	70
S	0	0	0
Total	195	224	419

Language

	1993-1994	1994-1995	Total
NH	136	141	277
NSH	44	63	107
S	15	20	35
Total	195	224	419

Writing Conventions

	1993-1994	1994-1995	Total
NH	120	128	248
NSH	42	53	95
S	33	43	76
Total	195	224	419

2.1.3 Spring Pass/Fail Data

	1993-1994	1994-1995	Total
Pass	58	78	136
Fail	137	146	283
Total	195	224	419

2.1.4 Spring Score Data

	1993-1994	1994-1995	Total
2	7	8	15
3	35	48	83
4	95	90	185
Total	137	146	283

2.1.5 Spring Subscore Data

Content Organization

	1993-1994	1994-1995	Total
NH	125	106	231
NSH	12	38	50
S	0	0	0
Total	137	144	281

Language

	1993-1994	1994-1995	Total
NH	97	71	168
NSH	26	48	74
S	14	25	39
Total	137	144	281

Writing Conventions

	1993-1994	1994-1995	Total
NH	76	74	150
NSH	29	31	60
S	32	39	71
Total	137	144	281

2.2 Comparison of Data by Group

2.2.1 Fall Score Data

	R-WISE	WRITE	CONTROL	TOTAL
2	2	1	10	13
3	43	1	36	80
4	171	29	126	326
Total	216	31	172	419

2.2.2 Fall Subscore Data

Content Organization

	R-WISE	WRITE	CONTROL	TOTAL
NH	190	22	137	349
NSH	26	9	35	70
S	0	0	0	0
Total	216	31	172	419

Language

	R-WISE	WRITE	CONTROL	TOTAL
NH	137	20	120	277
NSH	58	11	38	107
S	21	0	14	35
Total	216	31	172	419

Writing Conventions

	R-WISE	WRITE	CONTROL	TOTAL
NH	114	24	110	248
NSH	53	4	38	95
S	49	3	24	76
Total	216	31	172	419

2.2.3 Spring Pass/Fail Data

	R-WISE	WRITE	CONTROL	TOTAL
Pass	84	7	45	136
Fail	132	24	127	283
Total	216	31	172	419

2.2.4 Spring Score Data

	R-WISE	WRITE	CONTROL	TOTAL
2	3	0	12	15
3	36	7	40	83
4	93	17	75	185
Total	132	24	127	283

2.2.5 Spring Subscore Data

Content Organization

	R-WISE	WRITE	CONTROL	TOTAL
NH	99	20	112	231
NSH	31	4	15	50
S	0	0	0	0
Total	130	24	127	281

Language

	R-WISE	WRITE	CONTROL	TOTAL
NH	72	16	80	168
NSH	37	7	30	74
S	21	1	17	39
Total	130	24	127	281

Writing Conventions

	R-WISE	WRITE	CONTROL	TOTAL
NH	64	12	74	150
NSH	29	4	27	60
S	37	8	26	71
Total	130	24	127	281

APPENDIX A2

Fundamental Skills Tutor Correlation with Ohio Proficiency Test Data for the 1993-1994 and 1994-1995 School Years: Dunbar High School

Presented to the
Alliance for Education

March 7, 1996

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1.0 BACKGROUND

Several artificial intelligence-based software tutoring programs have been developed by the US Air Force's Armstrong Laboratory to aid in teaching of the fundamental skills of writing (R-WISE), science (ISIS), and algebra word problem solving (WPS). Each of these tutors has been field tested at Dayton Dunbar High School and Trotwood-Madison High School as well as several other sites across the nation. The design of the R-WISE and WPS tutors suggests they may help students pass the Ohio Proficiency Test (OPT). Through correlation of student usage of the tutor with OPT results, local researchers hoped to determine if the tutors were indeed an advantageous tool for preparation for this important exam. Of course, the tutors and Ohio Proficiency Test were not designed for use together. A lack of an improvement in OPT scores does not necessarily indicate that the students did not learn as a result of using the tutor, it could simply mean that the OPT is not the appropriate method of measurement for the tutor.

2.0 THE WORD PROBLEM SOLVING TUTOR/OPT ANALYSIS

This analysis includes data collected from Dayton Dunbar High School during the 1993-1994 and 1994-1995 school years.

2.1 THE WORD PROBLEM SOLVING TUTOR

The WPS tutor is divided into a series of modules which address various topics. These modules were designed to be appropriate for the class material covered in a general 9th grade Algebra course.

2.2 THE MATH SECTION OF THE OPT

The Ohio Department of Education has established a series of strands and learning outcomes which the math section of the Ohio Proficiency Test has been designed to measure. These strands and learning outcomes are listed in Table A2-1 and identified as to whether there are WPS tutor modules which address similar topics. Additional information about the mathematics learning outcomes is available in information published by the Ohio Department of Education.

Examples of test results from the math section of the Ohio Proficiency Test are given in Table A2-2. Each section of the Ohio Proficiency Test is scored on three levels. The first level is a pass/fail marking. A student who passes the test is not given any further scoring (i.e. score or subscores are omitted), and only a passing mark is returned to the school. A student who fails the math section of the test is then given a general score which can range from 0 to 199 given to three significant figures (i.e. 176, 180,...). The student is then given a subscore ranking in each of the five following strand areas: Arithmetic, Measurement, Geometry, Data Analysis, and Algebra. The possible subscore rankings are +, *, or – as defined in Table A2-2.

Through analysis of the goals and directives of the WPS tutor and the Ohio Proficiency Test, it was determined by the researchers that the WPS tutor did not directly address the issues evaluated in the Data Analysis subscore area. Therefore, the tutor would not be expected to increase student performance in this area. The other areas, however, were believed to be addressed by the tutor and should be impacted by tutor usage.

2.3 STUDY POPULATIONS

The study population included only those students who failed the math section of the Ohio Proficiency Test in the fall of the year of study and for whom data was available for the spring test of that same year. Data was collected for the 1993-1994 school year and the 1994-1995 school year. The sample size for each population group and year is given in Table A2-3.

Table A2-1: WPS tutor modules and OPT mathematics strands.

OPT MATHEMATICS STRANDS	FOCUS OF WPS TUTOR
Arithmetic	
1. Compute with whole numbers, fractions, and decimals	1. Yes
2. Compare, order, and determine equivalence of fractions, decimals, percents, whole numbers, and integers	2. No
3. Solve and use proportions	3. Yes
4. Round numbers to the nearest thousand, hundred, ten, one, tenth, and hundredth	4. Yes
5. Solve problems and make applications involving percentages	5. Yes
Measurement	
6. Select and compute with appropriate standard or metric units to measure length, area, volume, angles, weight, capacity, time, temperature, and money	6. No
7. Convert, compare, and compute with common units of measure within the same measurement system	7. Yes
8. Read the scale on a measurement device to the nearest mark and make interpolations where appropriate	8. No
Geometry	
9. Recognize, classify, and use characteristics of lines and simple two-dimensional figures	9. No
10. Find the perimeters (circumference) and areas of polygons (circles)	10. Yes
11. Find surface areas and volumes of rectangular solids	11. Yes
Data Analysis	
12. Read, interpret, and use tables, charts, maps, and graphics to identify patterns, note trends, and draw conclusions	12. No
13. Use elementary notions of probability	13. No
14. Compute averages	14. No
Algebra	
15. Solve simple number sentences and use formulas	15. Yes
16. Evaluate algebraic expressions (simple substitutions)	16. Yes

Table A2-2: Sample results for the math section of the Ohio Proficiency Test.

NAME	PASS or FAIL	SCORE	MEASURE-MENT	ARITH-METIC	GEOM-ETRY	DATA ANALYSIS	ALGE-BRA
Larry Student	Pass						
Mary Student	Fail	182	+	–	–	*	–
Carry Student	Fail	176	–	–	–	+	*
Berry Student	Fail	196	+	+	–	*	*

– = Performance lower than expected of students at the standard

* = Performance approximately the same as expected of students at the standard

+ = Performance higher than expected of students at the standard

Table A2-3: Number of students included in WPS data analysis for each group and year.

	WPS	Control	Total
93-94 School Year	82	33	115
94-95 School Year	38	103	141
Total	**120**	**136**	**256**

2.3.1 CONTROL

The control population included students who were enrolled in an algebra class which did not use the Air Force-developed software designed to enhance word problem solving proficiency. The control population would include students who were operating at class level, above class level, and below class level. For the purposes of this study, the control population was assumed to be equivalent to the treatment population. The accuracy of this

assumption can be validated by comparison of fall scores and subscores on the Ohio Proficiency Test. This assumption is further validated by the fact that the study population was limited to students who failed the math portion of the Ohio Proficiency Test during the fall of the year in question.

2.3.2 WPS

The WPS population included students from Dunbar High School who were enrolled in an algebra class which used the WPS tutor. This group represents the experimental population in this study.

2.4 DATA ANALYSIS

In all cases a Chi-Square analysis with a confidence interval of 5% was used to determine the statistical significance of the data. This indicates that if the numbers are statistically significant, then there is at least a 95% certainty that the same statistics would be observed in other, equivalent, populations. Tabular representations of all of the data presented are included in the appendix.

2.4.1 FALL

2.4.1.1 PASS/FAIL ANALYSIS

Due to the fact that the study population was limited to students who failed the OPT in the fall, no comparison can be made in this area.

2.4.1.2 SCORE ANALYSIS

Due to the nearly continuous spread in the scores for the math section of the OPT, this analysis is complex and is not available at this time.

2.4.1.3 SUBSCORE ANALYSIS

Chi-Squared analysis of fall subscores showed no statistically significant variance in the groups (Figure A2-1). This indicates that the treatment and control groups were statistically equivalent at the beginning of the year. This enhances the validity of our comparison between these two groups.

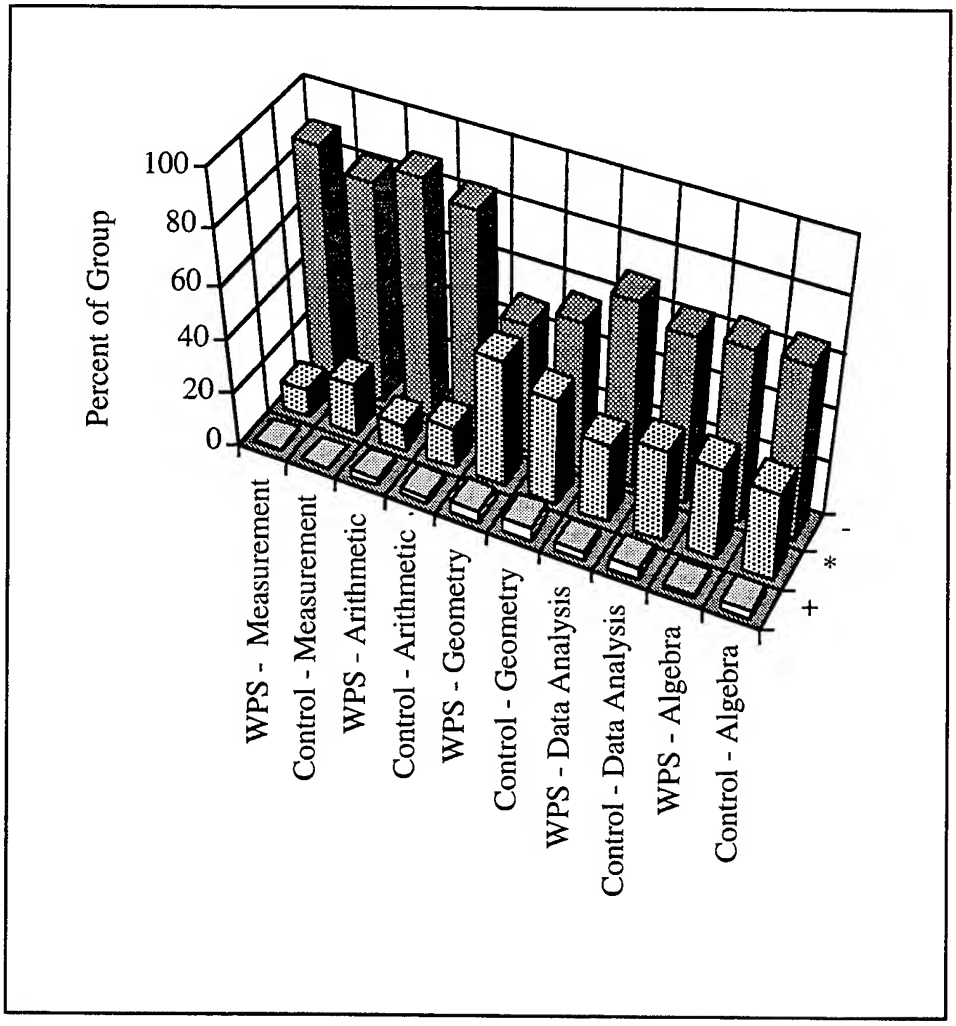

Figure A2-1: Fall subscore by group for WPS analysis. Subscore rankings are: performed lower than expected for students at the standard (–), performed approximately the same as expected of students at the standard (*), or performed higher than expected of students at the standard (+). The differences between the groups are <u>not</u> statistically significant.

2.4.2 SPRING

2.4.2.1 PASS/FAIL ANALYSIS

This measure of the data gives the clearest representation of the effectiveness of the tutor at helping students pass the OPT. The goal of each student is to pass the test. An increase in score may suggest an increase in ability, but without passing the test the students and schools do not measure any great improvement. Figure A2-2 displays the percentage of students in the treatment and control groups passing the test during the spring of the year of study. These differences are not statistically significant.

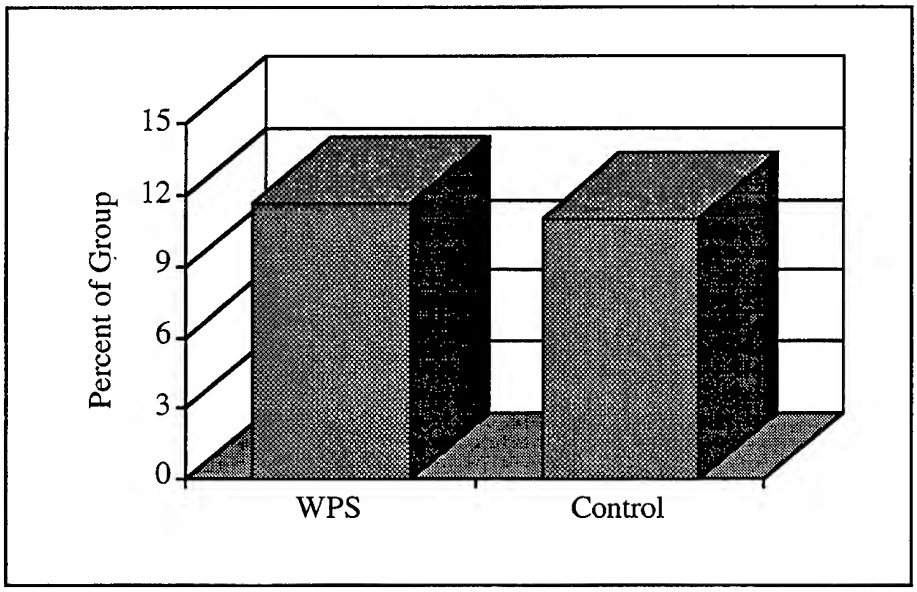

Figure A2-2: Passing percent by group for WPS analysis. The difference between the groups is not statistically significant.

This suggests that use of the WPS tutor had no effect on student passing rates for the math section of the OPT. The lack of a difference in the passing rates could easily be attributed to other variables such as teacher differences, student population differences, and other non-controlled variables.

2.4.2.2 SCORE ANALYSIS

Due to the nearly continuous spread in the scores for the math section of the OPT, this analysis is complex and is not available at this time.

2.4.2.3 SUBSCORE ANALYSIS

The Chi-Squared analysis of spring subscores showed no statistically significant variance in the subscore categories for any of the scored areas (Figure A2-3).

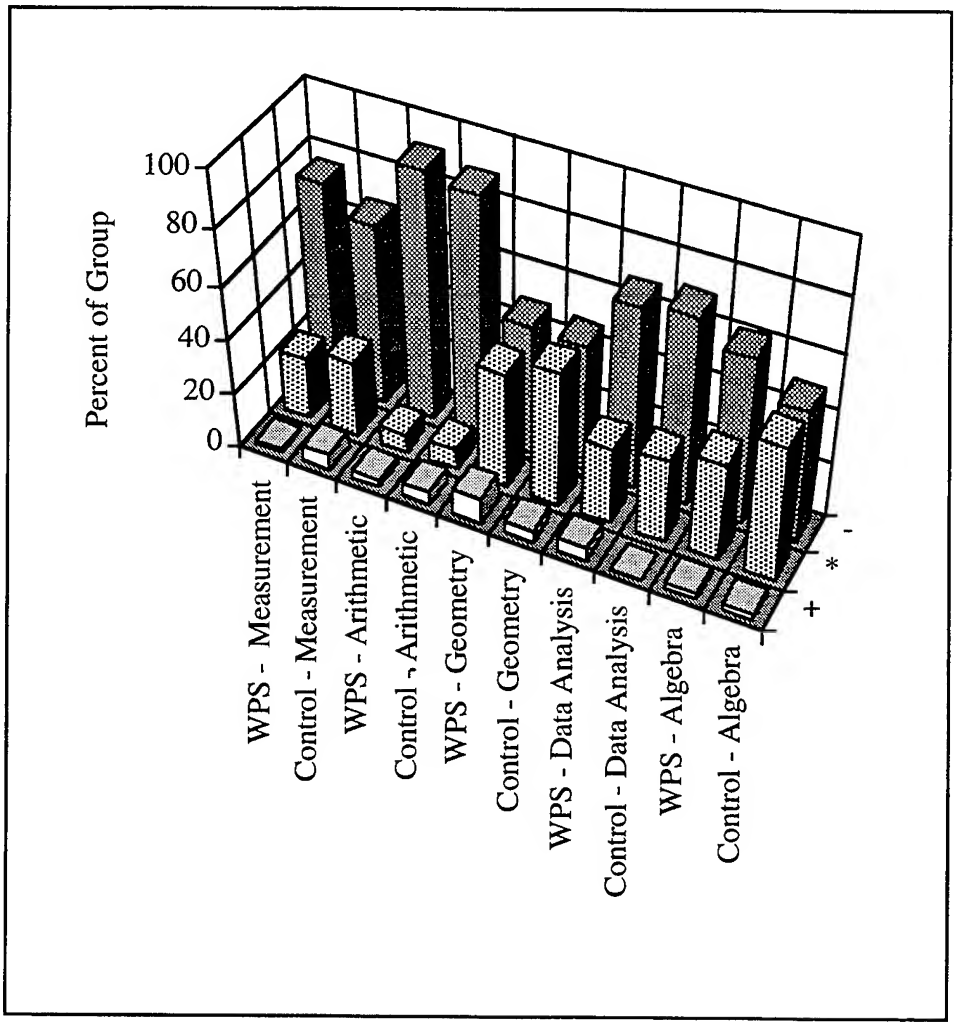

Figure A2-3: Spring subscore by group for WPS analysis. Subscore rankings are: performed lower than expected for students at the standard (–), performed approximately the same as expected of students at the standard (*), or performed higher than expected of students at the standard (+).

The area of Data Analysis was almost statistically significant with a Chi-Square probability of 0.052. This would suggest that the WPS group may have performed significantly better than the control group in this area. However, the tutor did not appear to address the goals of the Data Analysis area, so any correlation between tutor use and an improvement in scores in this area is suspicious. This again suggests that either the tutor is not effective or the OPT is not a good measure of the effect of the tutor.

2.5 RESULTS OF WPS TUTOR ANALYSIS

Although a lot of data was collected and analyzed, the most relevant question to be answered relates to the effectiveness of use of the tutor to aid students with passing the OPT. The fact that the study population was limited to students who failed the math portion of the OPT in the fall, and that the comparison of subscores between groups in the fall suggests that the groups were statistically equivalent at the beginning of the school year, suggests that this statistical comparison between students who did and did not use the tutor should be valid. It does not, however, mean that the OPT is a valid test to measure student learning with the WPS tutor. It will simply be an indication of whether students who used the tutor performed better on the OPT.

The lack of any statistical significance in the passing rate of the students who used the WPS tutor over those who did not indicates that the WPS software may not be effective at helping students pass this important exam. It could also, however, simply be a reflection of the inability of OPT data to reflect learning accomplished through the use of the tutor.

Of course, other factors not controlled by the researchers can always affect the observed results. School curriculum, student populations, teacher experience and style, and mid-year updates of the tutors themselves could all play a part by affecting the data analysis.

3.0 THE R-WISE TUTOR/OPT ANALYSIS

This analysis includes data collected from Dayton Dunbar High School and Dayton Belmont High School during the 1993-1994 and 1994-1995 school years.

3.1 THE R-WISE TUTOR

The R-WISE tutor (Reading and Writing in a Supportive Environment) is divided into a series of tools which address various topics. Through observation and use of the tutor and analysis of some of the literature provided by Armstrong Laboratory on the objectives of the tutor, correlations were made between the writing characteristics and learning outcomes defined by the Ohio Department of Education for the OPT and the tutor itself. This comparison is shown in Table A2-4.

3.2 THE WRITING SECTION OF THE OPT

The Ohio Department of Education has established a series of characteristics and learning outcomes which the writing section of the Ohio Proficiency Test has been designed to measure. Table A2-4 lists the writing characteristics and related learning outcomes as defined by the Ohio Department of Education.

Examples of possible test results from the writing section of the Ohio Proficiency Test are given in Table A2-5. The writing section of the OPT is scored on three levels. The first level is a pass/fail marking. A student who passes the test is not given any further scoring (i.e. score or subscores are omitted), and only a passing mark is returned to the school. A student who fails the writing section of the test is then given a general score which can range from 0 to 4.5 given in two significant figures (i.e. 3.5, 4.0,...). The student is then given a subscore ranking in each of the three following characteristic areas: Content/Organization, Language, and Writing Conventions. The possible subscore rankings are; satisfactory, needs some help, or needs help.

Table A2-4: OPT writing characteristics and R-WISE tutor objectives.

OPT WRITING CHARACTERISTICS	FOCUS OF R-WISE TUTOR
Content/Organization	
1. Conveys a message related to the prompt	1. Yes
2. Includes supporting ideas or examples	2. Yes
3. Follows a logical order	3. Yes
4. Conveys a sense of completeness	4. Yes
Language	
5. Exhibits word choice appropriate to the audience, purpose, and subject	5. Yes
6. Includes clear language	6. No
Writing Conventions	
7. Contains complete sentences and may contain purposeful fragments	7. No
8. Exhibits subject-verb agreement	8. No
9. Contains standard forms of verbs and nouns	9. No
10. Exhibits appropriate punctuation	10. No
11. Exhibits appropriate capitalization	11. No
12. Contains correct spelling	12. No
13. Is legible	13. No

Table A2-5: Sample results for the writing section of the Ohio Proficiency Test.

NAME	PASS or FAIL	SCORE	ORGANIZATION	LANGUAGE	WRITING CONVENTIONS
Larry Student	Pass				
Mary Student	Fail	4.0	NH	NSH	S
Carry Student	Fail	3.5	NSH	NH	NH
Berry Student	Fail	4.5	NH	NH	S

S = Satisfactory
NSH = Needs Some Help
NH = Needs Help

Through analysis of the goals and directives of the R-WISE tutor and the Ohio Proficiency Test, it was determined by the researchers that the R-WISE tutor did not directly address the issues evaluated in the Writing Conventions subscore area. Therefore, the tutor would not be expected to increase student performance in this area. The other areas, however, were believed to be addressed by the tutor and should be affected by tutor usage.

3.3 STUDY POPULATIONS

The study population included only those students who failed the writing section of the Ohio Proficiency Test in the fall of the year of study and for whom data were available for the spring test of that same year. Data were collected for the 1993-1994 school year and the 1994-1995 school year. The sample.size for each population group and year is given in Table A2-6.

Table A2-6: Number of students included in R-WISE data analysis for each group and year.

	R-WISE Dunbar	WRITE Dunbar	Control Belmont	Total
93-94 School Year	25	19	53	97
94-95 School Year	36	0	77	113
Total	**61**	**19**	**130**	**210**

3.3.1 CONTROL

The control population included students who were not exposed to any Air Force-developed software designed to enhance writing proficiency. The majority of this population were students in the ninth grade at Belmont High School. Because class rosters were not always available for classes which did not use the tutor, the remaining 9th grade population was used. As a result students who were enrolled in a class other than a standard 9th grade English class would be included in this population group. This could include students who were in honors-level or remedial-level courses. In either case the control population would include students who were operating at class level, above class level, and below class level. For the purposes of this study, the control population was assumed to be equivalent to the treatment population. The accuracy of this assumption can be validated by comparison of fall scores and subscores on the Ohio Proficiency Test. This assumption is further validated by the fact that the study population was limited to students who failed the writing portion of the Ohio Proficiency Test during the fall of the year in question.

3.3.2 WRITE

The WRITE population included students from Dunbar High School who were enrolled in a standard 9th grade English class which used a simple word processor to assist in writing. The software did not contain any of the tutor assistance available in the more advanced version of the tutor. This group was used to study the effect of technology usage alone compared to the use of the more advanced tutor.

3.3.3 R-WISE

The R-WISE population included students from Dunbar High School who were enrolled in a standard 9th grade English class which used the advanced R-WISE tutor. This group represents the true experimental population in this study.

3.4 DATA ANALYSIS

In all cases a Chi-Square analysis with a confidence interval of 5% was used to determine the statistical significance of the data. This indicates that if the numbers are statistically significant, then there is at least a 95% certainty that the same statistics would be observed in other, equivalent, populations. Tabular representations of all of the data presented are included in the appendix.

3.4.1 FALL

3.4.1.1 PASS/FAIL ANALYSIS

Due to the fact that the study population was limited to students who failed the OPT in the fall, no comparison can be made in this area.

3.4.1.2 SCORE ANALYSIS

The Chi-Squared analysis of fall scores showed no statistically significant variance in the data (Figure A2-4). This suggests that the R-WISE and control populations were equivalent at the beginning of each year of the study.

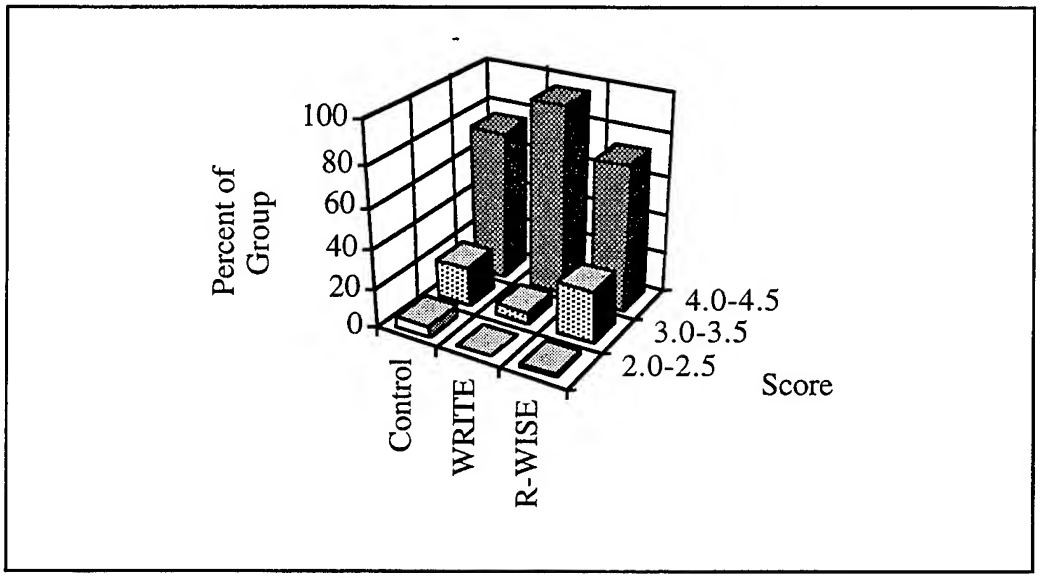

Figure A2-4: Fall score by group for R-WISE analysis.

3.4.1.3 SUBSCORE ANALYSIS

Comparison of the fall subscores between groups showed that the groups were statistically equivalent in all of the subscore areas except Writing Conventions (See Figure A2-5). In this area the R-WISE and control groups appeared to perform better than the WRITE group.

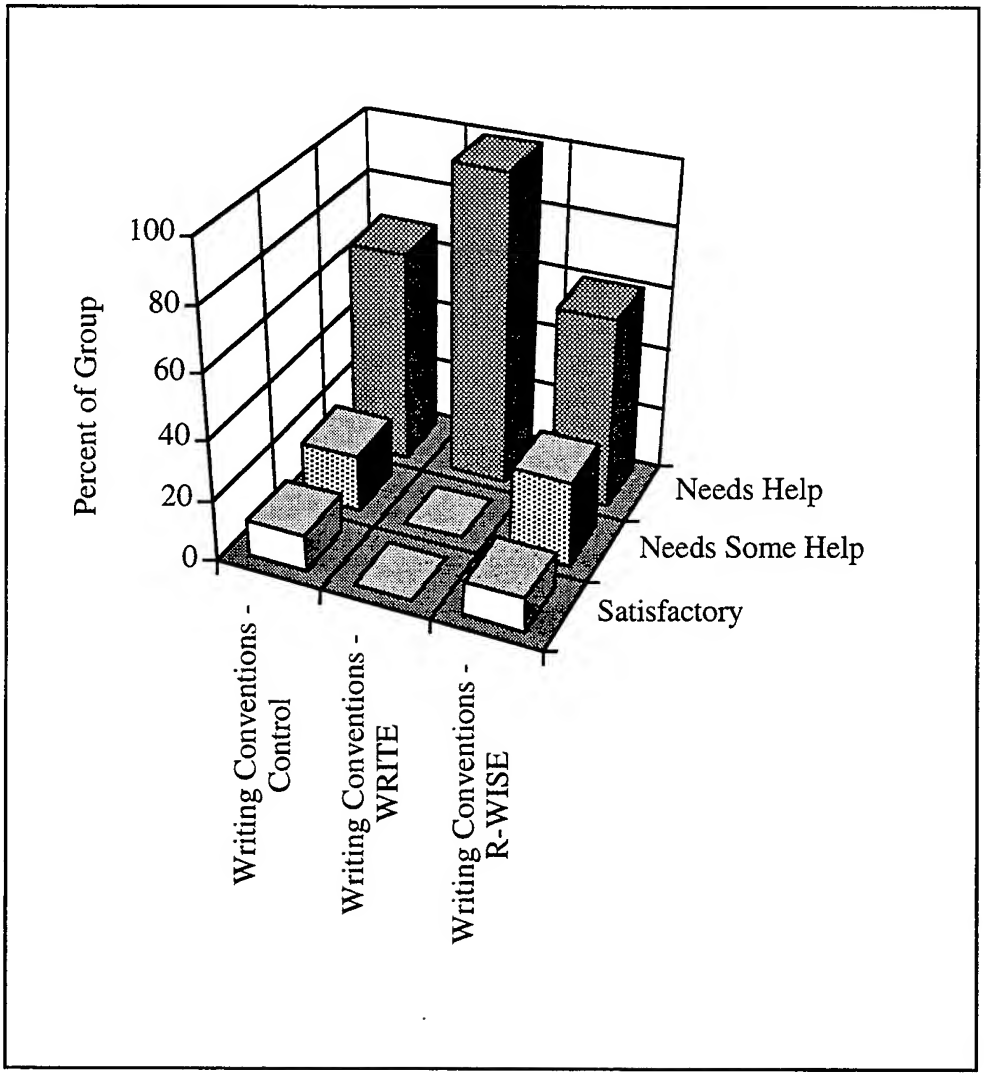

Figure A2-5: Fall subscore by group for R-WISE analysis.

3.4.2 SPRING

3.4.2.1 PASS/FAIL ANALYSIS

This measure of the data gives the clearest representation of the effectiveness of the tutor at helping students pass the OPT. The goal of each student is to pass the test. An increase in score may suggest an increase in ability, but without passing the test the students and schools do not measure any great improvement. Figure A2-6 displays the percentage of

students in each group passing the test during the spring of the year of study. These differences are not statistically significant and do not, therefore, indicate the performance of the tutor.

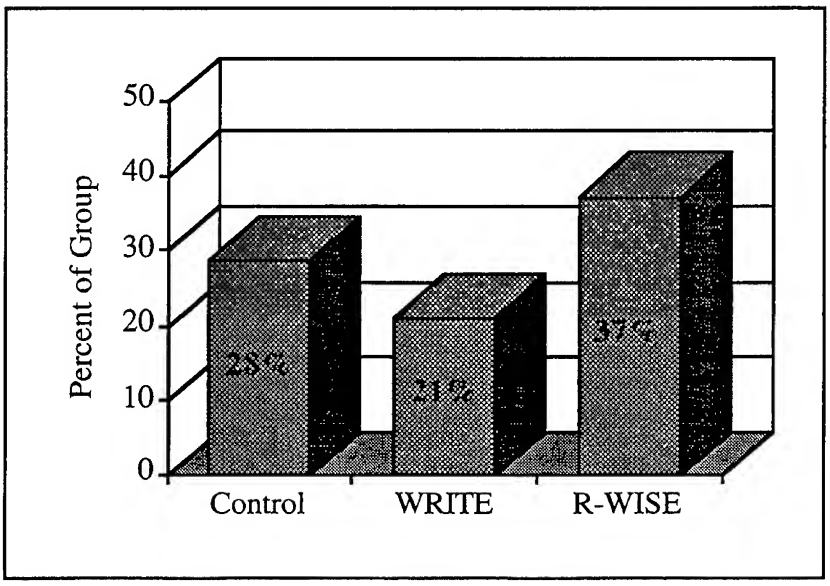

Figure A2-6: Passing percent by group for R-WISE analysis. The differences in the passing rates are not statistically significant.

3.4.2.2 SCORE ANALYSIS

The Chi-Squared analysis of spring scores showed no statistically significant variance in the data. The groups scores were statistically equivalent in the fall and remained that way in the spring. Therefore, this analysis does not suggest that the R-WISE tutor had any measurable affect on student performance.

3.4.2.3 SUBSCORE ANALYSIS

Comparison of spring subscores by group showed no statistical significance in any of the subscore areas. In the fall subscore comparison of these groups, they were not statistically

equivalent in the area Writing Conventions, with the R-WISE and control groups performing better than the WRITE group. Now, after exposure of the R-WISE and WRITE groups to computer-based training, all the groups are statistically equivalent. This suggests that during regular classroom instruction, the WRITE group was able to improve in order to be equivalent with the other two groups.

These data do not provide any support for the ability of the R-WISE tutor to improve student performance on the OPT.

3.5 RESULTS OF R-WISE DATA ANALYSIS

The data presented here are inconclusive as to whether the R-WISE tutor increases student performance on the Ohio Proficiency Test. The relatively small sample size could have an effect on this result as well as other factors not controlled by the researchers. The fact that a large percentage of the control population came from another school may be a cause for concern. Likewise, differences in school curriculums, student populations, teacher experience and style, and mid-year updates of the tutors themselves could all play a part in affecting the data analysis.

4.0 CONCLUSIONS

No significant differences in the passing rates were noted as a result of exposure to either the WPS or R-WISE tutors. This could be a result of either the tutor not affecting student performance, the Ohio Proficiency Test being a poor measure of tutor effectiveness, or too small of a sample size. Of course, other factors such as student population variations, teacher differences, and curriculum differences could also have an effect on these results and must always be considered.

APPENDIX - TABULATED DATA

1.0 WPS TUTOR

1.1 Fall Subscore Data

Measurement

	WPS	Control	Total
–	106	110	216
*	13	26	39
+	1	0	1
Total	120	136	256

Arithmetic

	WPS	Control	Total
–	105	112	217
*	12	21	33
+	3	3	6
Total	120	136	256

Geometry

	WPS	Control	Total
–	58	75	133
*	57	54	111
+	5	7	12
Total	120	136	256

Data Analysis

	WPS	Control	Total
–	82	85	167
*	35	46	81
+	3	5	8
Total	120	136	256

Algebra

	WPS	Control	Total
–	77	88	165
*	41	44	85
+	2	4	6
Total	120	136	256

1.2.2 Spring Pass/Fail Data

	WPS	Control	Total
Pass	14	15	29
Fail	106	121	227
Total	120	136	256

1.2.3 Spring Subscore Data

Measurement

	WPS	Control	Total
–	80	80	160
*	25	34	59
+	1	7	8
Total	106	121	227

Arithmetic

	WPS	Control	Total
–	95	106	201
*	7	9	16
+	3	6	9
Total	105	121	226

Geometry

	WPS	Control	Total
–	50	56	106
*	45	60	105
+	10	5	15
Total	105	121	226

Data Analysis

	WPS	Control	Total
–	70	84	154
*	30	37	67
+	5	0	5
Total	105	121	226

Algebra

	WPS	Control	Total
–	64	59	123
*	38	60	98
+	3	2	5
Total	105	121	226

2.0 R-WISE TUTOR

2.1 Fall Score Data

	R-WISE	WRITE	CONTROL	TOTAL
2	1	0	7	8
3	16	1	26	43
4	45	18	97	160
Total	62	19	130	211

2.2 Fall Subscore Data

Content Organization

	R-WISE	WRITE	CONTROL	TOTAL
NH	53	12	98	163
NSH	9	7	32	48
S	0	0	0	0
Total	62	19	130	211

Language

	R-WISE	WRITE	CONTROL	TOTAL
NH	45	12	92	149
NSH	9	7	29	45
S	8	0	9	17
Total	62	19	130	211

Writing Conventions

	R-WISE	WRITE	CONTROL	TOTAL
NH	38	19	89	146
NSH	17	0	25	42
S	7	0	16	23
Total	62	19	130	211

2.3 Spring Pass/Fail Data

	R-WISE	WRITE	CONTROL	TOTAL
Pass	23	4	37	64
Fail	39	15	93	147
Total	62	19	130	211

2.4 Spring Score Data

	R-WISE	WRITE	CONTROL	TOTAL
2	0	0	7	7
3	12	6	30	48
4	27	9	56	92
Total	39	15	93	147

2.5 Spring Subscore Data

Content Organization

	R-WISE	WRITE	CONTROL	TOTAL
NH	27	11	78	116
NSH	12	4	15	31
S	0	0	0	0
Total	39	15	93	147

Language

	R-WISE	WRITE	CONTROL	TOTAL
NH	23	11	53	87
NSH	9	4	24	37
S	7	0	16	23
Total	39	15	93	147

Writing Conventions

	R-WISE	WRITE	CONTROL	TOTAL
NH	21	10	54	85
NSH	7	2	20	29
S	11	3	19	33
Total	39	15	93	147

APPENDIX A3

Fundamental Skills Tutor Correlation with Ohio Proficiency Test Data for the 1993-1994 and 1994-1995 School Years: Trotwood-Madison High School

Presented to the
Alliance for Education

March 7, 1996

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1.0 BACKGROUND

Several artificial intelligence-based software tutoring programs have been developed by the US Air Force's Armstrong Laboratory to aid in teaching of the fundamental skills of writing (R-WISE), science (ISIS), and algebra word problem solving (WPS). Each of these tutors has been field tested at Dayton Dunbar High School and Trotwood-Madison High School as well as several other sites across the nation. The design of the R-WISE and WPS tutors suggests they may help students pass the Ohio Proficiency Test (OPT). Through correlation of student usage of the tutor with OPT results, local researchers hoped to determine if the tutors were indeed an advantageous tool for preparation for this important exam. Of course, the tutors and Ohio Proficiency Test were not designed for use together. A lack of an improvement in OPT scores does not necessarily indicate that the students did not learn as a result of using the tutor, it could simply mean that the OPT is not the appropriate method of measurement for the tutor.

2.0 THE WORD PROBLEM SOLVING TUTOR/OPT ANALYSIS

This analysis includes data collected from Trotwood-Madison High School during the 1993-1994 and 1994-1995 school years.

2.1 THE WORD PROBLEM SOLVING TUTOR

The WPS tutor is divided into a series of modules which address various topics. These modules were designed to be appropriate for the class material covered in a general 9th grade Algebra course.

2.2 THE MATH SECTION OF THE OPT

The Ohio Department of Education has established a series of strands and learning outcomes which the math section of the Ohio Proficiency Test has been designed to measure. These strands and learning outcomes are listed in Table A3-1 and identified as to whether there are WPS tutor modules which address similar topics. Additional information about the mathematics learning outcomes is available in information published by the Ohio Department of Education.

Examples of test results from the math section of the Ohio Proficiency Test are given in Table A3-2. Each section of the Ohio Proficiency Test is scored on three levels. The first level is a pass/fail marking. A student who passes the test is not given any further scoring (i.e. score or subscores are omitted), and only a passing mark is returned to the school. A student who fails the math section of the test is then given a general score which can range from 0 to 199 given to three significant figures (i.e. 176, 180,...). The student is then given a subscore ranking in each of the five following strand areas: Arithmetic, Measurement, Geometry, Data Analysis, and Algebra. The possible subscore rankings are +, *, or – as defined in Table A3-2.

Through analysis of the goals and directives of the WPS tutor and the Ohio Proficiency Test, it was determined by the researchers that the WPS tutor did not directly address the issues evaluated in the Data Analysis subscore area. Therefore, the tutor would not be expected to increase student performance in this area. The other areas, however, were believed to be addressed by the tutor and should be impacted by tutor usage.

2.3 STUDY POPULATIONS

The study population included only those students who failed the math section of the Ohio Proficiency Test in the fall of the year of study and for whom data was available for the spring test of that same year. Data were collected for the 1993-1994 school year and the 1994-1995 school year. The sample size for each population group and year are given in Table A3-3.

Table A3-1: WPS tutor modules and OPT mathematics strands.

OPT MATHEMATICS STRANDS	FOCUS OF WPS TUTOR
Arithmetic	
1. Compute with whole numbers, fractions, and decimals	1. Yes
2. Compare, order, and determine equivalence of fractions, decimals, percents, whole numbers, and integers	2. No
3. Solve and use proportions	3. Yes
4. Round numbers to the nearest thousand, hundred, ten, one, tenth, and hundredth	4. Yes
5. Solve problems and make applications involving percentages	5. Yes
Measurement	
6. Select and compute with appropriate standard or metric units to measure length, area, volume, angles, weight, capacity, time, temperature, and money	6. No
7. Convert, compare, and compute with common units of measure within the same measurement system	7. Yes
8. Read the scale on a measurement device to the nearest mark and make interpolations where appropriate	8. No
Geometry	
9. Recognize, classify, and use characteristics of lines and simple two-dimensional figures	9. No
10. Find the perimeters (circumference) and areas of polygons (circles)	10. Yes
11. Find surface areas and volumes of rectangular solids	11. Yes
Data Analysis	
12. Read, interpret, and use tables, charts, maps, and graphics to identify patterns, note trends, and draw conclusions	12. No
13. Use elementary notions of probability	13. No
14. Compute averages	14. No
Algebra	
15. Solve simple number sentences and use formulas	15. Yes
16. Evaluate algebraic expressions (simple substitutions)	16. Yes

Table A3-2: Sample results for the math section of the Ohio Proficiency Test.

NAME	PASS or FAIL	SCORE	MEASURE-MENT	ARITH-METIC	GEOM-ETRY	DATA ANALYSIS	ALGE-BRA
Larry Student	Pass						
Mary Student	Fail	182	+	–	–	*	–
Carry Student	Fail	176	–	–	–	+	*
Berry Student	Fail	196	+	+	–	*	*

– = Performance lower than expected of students at the standard

* = Performance approximately the same as expected of students at the standard

+ = Performance higher than expected of students at the standard

Table A3-3: Number of students included in the WPS data analysis for each group and year.

	WPS		Control		
	Practical Algebra	Workshop	Practical Algebra	Workshop	Total
93-94 School Year	55	20	0	0	75
94-95 School Year	37	72	53	52	214
Total	92	92	53	52	289

2.3.1 CONTROL

The control population included students who were enrolled in an algebra class which did not use the Air Force-developed software designed to enhance word problem solving proficiency. During the first year of the study, no control population was available at Trotwood-Madison High School. Regardless, the control population would include

students who were operating at class level, above class level, and below class level. For the purposes of this study, the control population was assumed to be equivalent to the treatment population. The accuracy of this assumption can be validated by comparison of fall scores and subscores on the Ohio Proficiency Test. This assumption is further validated by the fact that the study population was limited to students who failed the math portion of the Ohio Proficiency Test during the fall of the year in question.

2.3.2 WPS

The WPS population included students from Trotwood-Madison High Schools who were enrolled in either a Practical Algebra or Workshop class which used the WPS tutor. This group represents the experimental population in this study.

2.4 DATA ANALYSIS

In all cases, a Chi-Square analysis with a confidence interval of 5% was used to determine the statistical significance of the data. This indicates that if the numbers are statistically significant, then there is at least a 95% certainty that the same statistics would be observed in other, equivalent, populations. Tabular representations of all of the data presented are included in the appendix.

2.4.1 FALL

2.4.1.1 PASS/FAIL ANALYSIS

Due to the fact that the study population was limited to students who failed the OPT in the fall, no comparison can be made in this area.

2.4.1.2 SCORE ANALYSIS

Due to the nearly continuous spread in the scores for the math section of the OPT, this analysis is complex and is not available at this time.

2.4.1.3 SUBSCORE ANALYSIS

Data for the subscore analysis are shown in Figure A3-1 for the Practical Algebra classes and Figure A3-2 for the Workshop classes. Chi-Squared analysis of these fall subscores showed no statistically significant variance in the groups for either the Practical Algebra or Workshop classes. This indicates that the treatment and control groups were statistically equivalent at the beginning of the year. This enhances the validity of our comparison between these two groups.

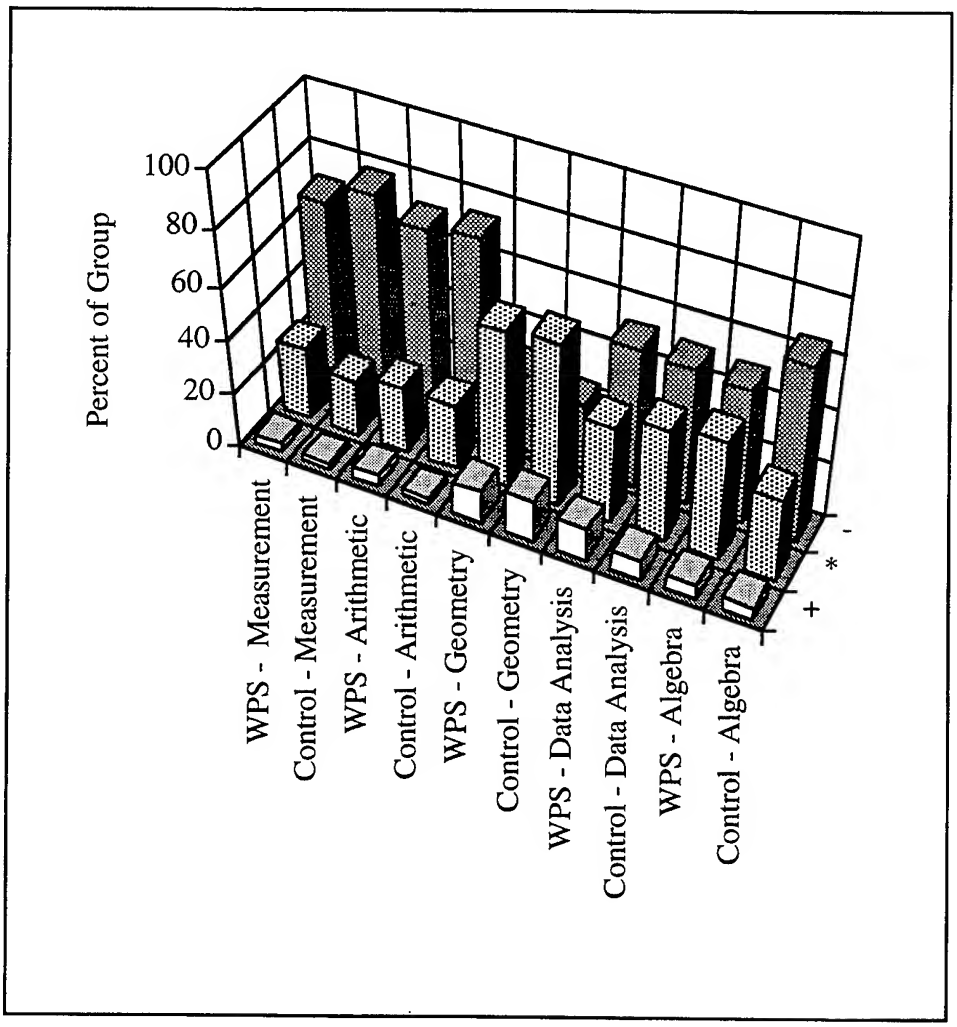

Figure A3-1: Fall subscore for Practical Algebra classes. The differences between the control group and WPS group are not statistically significant.

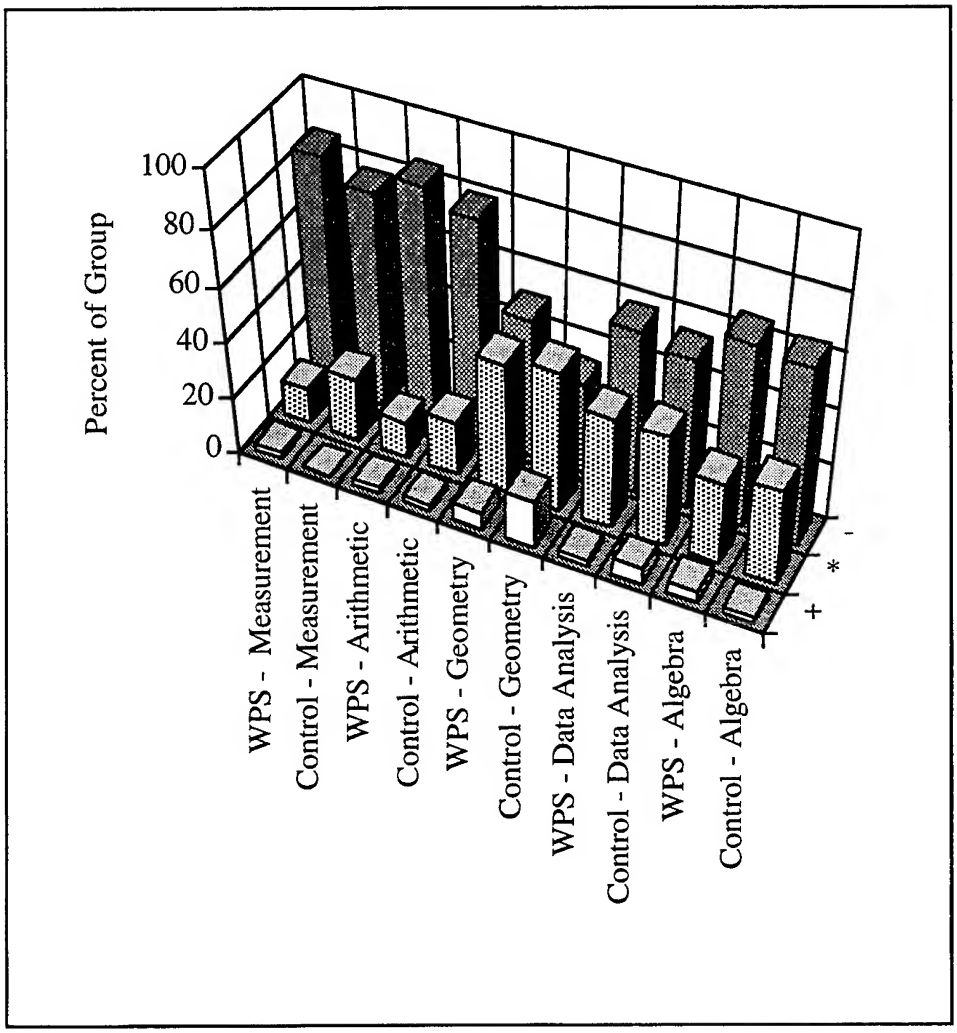

Figure A3-2: Fall subscore for Workshop classes. The differences between the control group and the WPS groups are <u>not</u> statistically significant.

2.4.2 SPRING

2.4.2.1 PASS/FAIL ANALYSIS

This measure of the data gives the clearest representation of the effectiveness of the tutor at helping students pass the OPT. The goal of each student is to pass the test. An increase in score may suggest an increase in ability, but without passing the test the students and

schools do not measure any great improvement. Figure A3-3 displays the percentage of Practical Algebra students in the WPS and control groups passing the test during the spring of the year of study. These differences are not statistically significant.

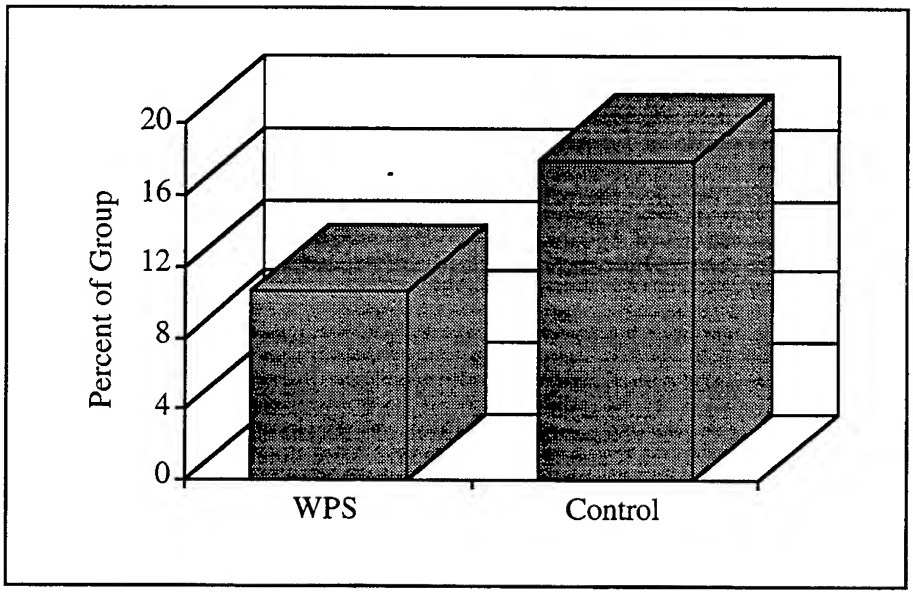

Figure A3-3: Passing percent for Practical Algebra classes. The difference between the groups is not statistically significant.

This suggests that use of the WPS tutor had no effect on these students passing the math section of the OPT. The lack of a difference in the passing rates could easily be attributed to other variables such as teacher differences, student population differences, and other non-controlled variables.

The results for the Workshop course were statistically significant and are shown in Figure A3-4. These results suggest that the tutor may have lowered the chances of the students being able to pass the OPT. This could be a result of loss of class time due to use of the tutor, if indeed the tutor does not help. However, this could also simply be a result of other differences between the treatment and control populations and could have no basis in tutor usage at all.

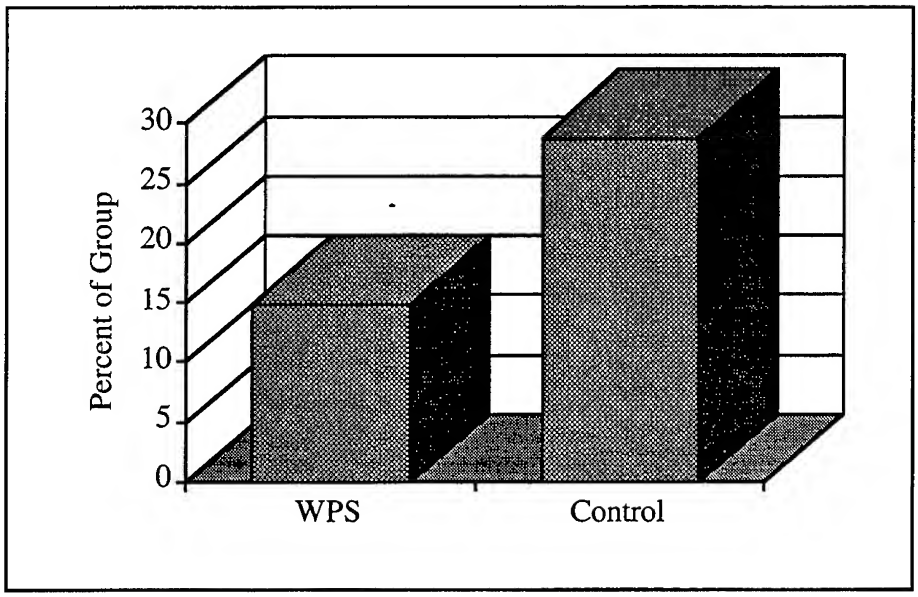

Figure A3-4: Passing percent for the Workshop classes. The difference between the groups is statistically significant.

2.4.2.2 SCORE ANALYSIS

Due to the nearly continuous spread in the scores for the math section of the OPT, this analysis is complex and is not available at this time.

2.4.2.3 SUBSCORE ANALYSIS

The Chi-Squared analysis of spring subscores for the Practical Algebra classes showed a statistically significant variance in the subscore categories of Data Analysis and Algebra (Figure A3-5). The other subscore categories did not show any significant difference between the treatment and the control populations. The area of Data Analysis was not believed to be addressed by the tutor. However, students who used the tutor appeared to do better in this subscore area. This could indicate that either the initial tutor goals were not properly identified, or the OPT is measuring another difference between the study populations. The control population appeared to perform better in the area of Algebra which should have been addressed by the tutor. This again suggests that either the tutor is not effective, or the OPT is not a good measure of the effect of the tutor.

The Chi-Squared analysis of the spring subscore data for the Workshop classes showed the two groups to be statistically equivalent in all areas except Arithmetic and Geometry. Both of these areas were believed to be addressed by the tutor. However, in both cases the control population appeared to perform better than the WPS population (Figure A3-6). This suggests, again, that either the tutor is not an effective method for teaching this material, or the OPT is not a good measurement technique for learning associated with the tutor.

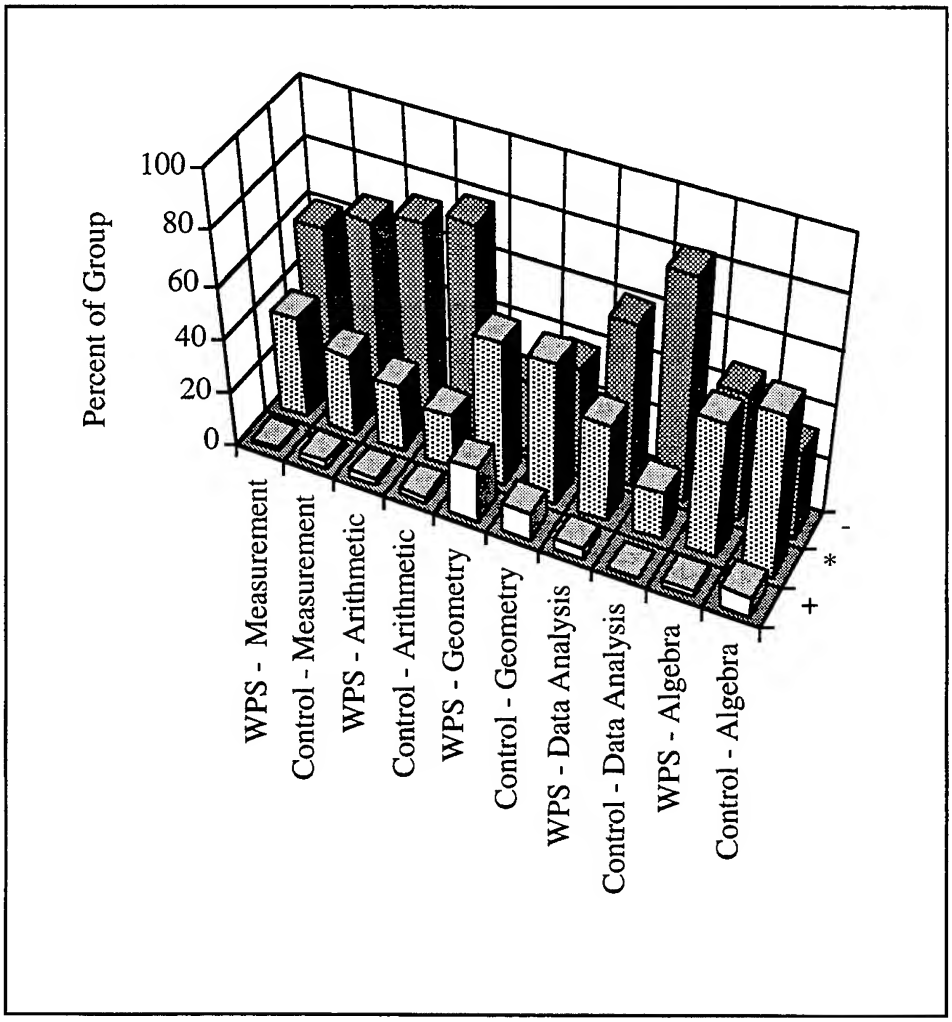

Figure A3-5: Spring subscore for Practical Algebra classes. Subscore rankings are: performed lower than expected for students at the standard (–), performed approximately the same as expected of students at the standard (*), or performed higher than expected of students at the standard (+).

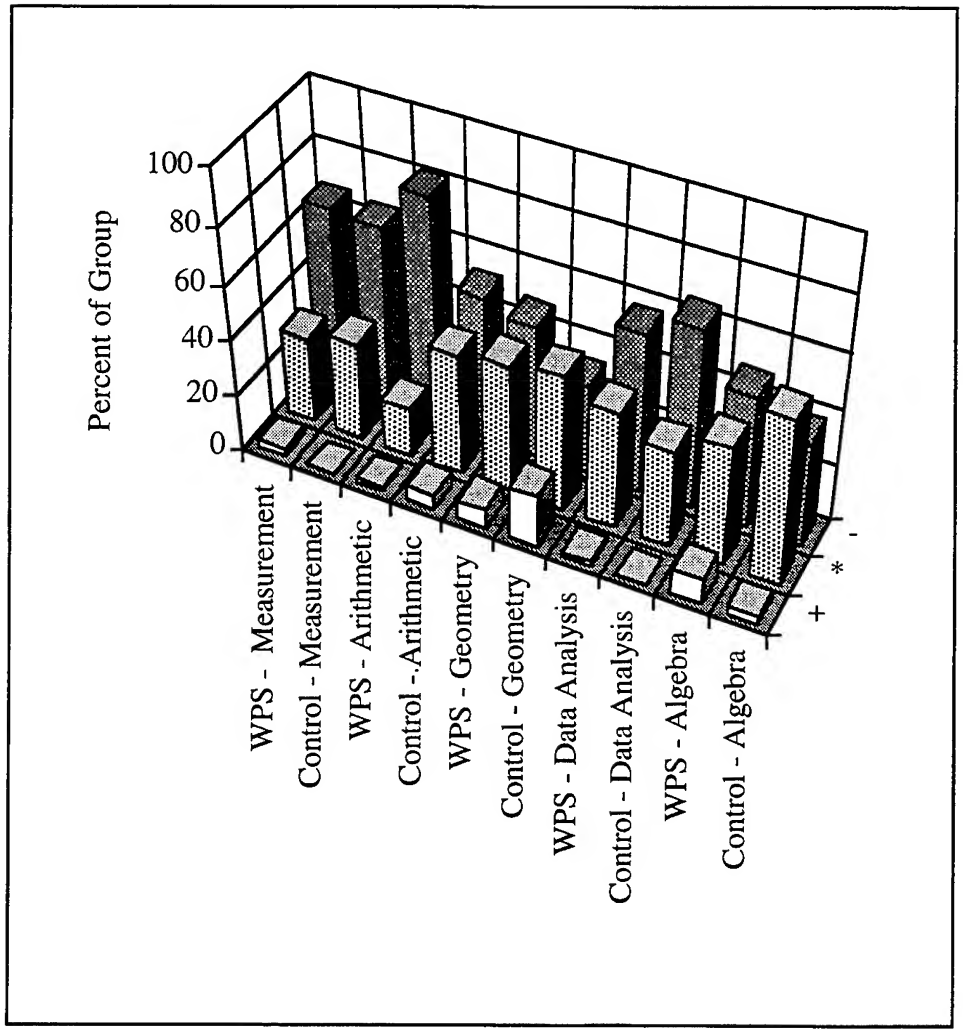

Figure A3-6: Spring subscore by group for the Workshop classes. Subscore rankings are: performed lower than expected for students at the standard (–), performed approximately the same as expected of students at the standard (*), or performed higher than expected of students at the standard (+).

2.5 RESULTS OF WPS TUTOR ANALYSIS

Although a lot of data were collected and analyzed, the most relevant question to be answered relates to the effectiveness of use of the tutor to aid students with passing the

OPT. The fact that the study population was limited to students who failed the math portion of the OPT in the fall, and that the comparison of subscores between groups in the fall suggests that the groups were statistically equivalent at the beginning of the school year, suggests that this statistical comparison between students who did and did not use the tutor should be valid. It does not, however, mean that the OPT is a valid test to measure student learning with the WPS tutor. It will simply be an indication of whether students who used the tutor performed better on the OPT.

The lack of any statistical significance in the passing rate of Practical Algebra students who used the WPS tutor over those who did not indicates that the WPS software may not be effective at helping students pass this important exam. The significant improvement in passing rate for students who did not use the tutor in the Workshop classes over students in Workshop classes which did use the tutor could suggest that the tutor is not an appropriate teaching aid for this group of students. It could also, however, simply be a reflection of the inability of OPT data to reflect learning accomplished through the use of the tutor.

The inconsistency of results between the Practical Algebra and Workshop classes (Table A3-4) could be a result of other differences in the study population and, therefore, their ability to learn from the WPS tutor, or it could be a result of the inability of the OPT to effectively measure the material which the students learned as a result of exposure to the tutor.

Table A3-4: Group which performed the best on a given area of the math section of the OPT.

	Practical Algebra		Workshop	
	Fall	**Spring**	**Fall**	**Spring**
Measurement	Equivalent	Equivalent	Equivalent	Equivalent
Arithmetic	Equivalent	Equivalent	Equivalent	Control
Geometry	Equivalent	Equivalent	Equivalent	Control
Data Analysis	Equivalent	WPS	Equivalent	Equivalent
Algebra	Equivalent	Control	Equivalent	Equivalent

Of course, other factors not controlled by the researchers can always affect the observed results. Differences in student populations, teacher experience and style, and mid-year updates of the tutors themselves could all play a part by affecting the data analysis.

3.0 THE R-WISE TUTOR/OPT ANALYSIS

This analysis includes data collected from Dayton Belmont High School and Trotwood-Madison High School during the 1993-1994 and 1994-1995 school years.

3.1 THE R-WISE TUTOR

The R-WISE tutor (Reading and Writing in a Supportive Environment) is divided into a series of tools which address various topics. Through observation and use of the tutor and analysis of some of the literature provided by Armstrong Laboratory on the objectives of the tutor in correlations were made between the writing characteristics and learning outcomes defined by the Ohio Department of Education for the OPT and the tutor itself. This comparison is shown in Table A3-5.

3.2 THE WRITING SECTION OF THE OPT

The Ohio Department of Education has established a series of characteristics and learning outcomes which the writing section of the Ohio Proficiency Test has been designed to measure. Table A3-5 lists the writing characteristics and related learning outcomes as defined by the Ohio Department of Education.

Examples of possible test results from the writing section of the Ohio Proficiency Test are given in Table A3-6. The writing section of the OPT is scored on three levels. The first level is a pass/fail marking. A student who passes the test is not given any further scoring (i.e. score or subscores are omitted), and only a passing mark is returned to the school. A student who fails the writing section of the test is then given a general score which can range from 0 to 4.5 given in two significant figures (i.e. 3.5, 4.0,...). The student is then given a subscore ranking in each of the three following characteristic areas:

Content/Organization, Language, and Writing Conventions. The possible subscore rankings are: satisfactory, needs some help, or needs help.

Table A3-5: OPT writing characteristics and R-WISE tutor objectives.

OPT WRITING CHARACTERISTICS	FOCUS OF R-WISE TUTOR
Content/Organization	
1. Conveys a message related to the prompt	1. Yes
2. Includes supporting ideas or examples	2. Yes
3. Follows a logical order	3. Yes
4. Conveys a sense of completeness	4. Yes
Language	
5. Exhibits word choice appropriate to the audience, purpose, and subject	5. Yes
6. Includes clear language	6. No
Writing Conventions	
7. Contains complete sentences and may contain purposeful fragments	7. No
8. Exhibits subject-verb agreement	8. No
9. Contains standard forms of verbs and nouns	9. No
10. Exhibits appropriate punctuation	10. No
11. Exhibits appropriate capitalization	11. No
12. Contains correct spelling	12. No
13. Is legible	13. No

Table A3-6: Sample results for the writing section of the Ohio Proficiency Test.

NAME	PASS or FAIL	SCORE	ORGANIZATION	LANGUAGE	WRITING CONVENTIONS
Larry Student	Pass				
Mary Student	Fail	4.0	NH	NSH	S
Carry Student	Fail	3.5	NSH	NH	NH
Berry Student	Fail	4.5	NH	NH	S

S = Satisfactory
NSH = Needs Some Help
NH = Needs Help

Through analysis of the goals and directives of the R-WISE tutor and the Ohio Proficiency Test, it was determined by the researchers that the R-WISE tutor did not directly address the issues evaluated in the Writing Conventions subscore area. Therefore, the tutor would not be expected to increase student performance in this area. The other areas, however, were believed to be addressed by the tutor and should be affected by tutor usage.

3.3 STUDY POPULATIONS

The study population included only those students who failed the writing section of the Ohio Proficiency Test in the fall of the year of study and for whom data were available for the spring test of that same year. Data were collected for the 1993-1994 school year and

the 1994-1995 school year. The sample size for each population group and year is given in Table A3-7.

Table A3-7: Number of students included in R-WISE data analysis for each group and year.

	R-WISE T-M	WRITE T-M	Control T-M	Total
93-94 School Year	44	12	42	98
94-95 School Year	111	0	0	111
Total	154	12	42	208

3.3.1 CONTROL

The control population included students who were not exposed to any Air Force-developed software designed to enhance writing proficiency. The majority of this population were students in the ninth grade at Trotwood-Madison High School during the 93-94 school year who were not enrolled in a ninth grade English class which used the tutor. Because class rosters were not available for classes which did not use the tutor, the remaining 9th grade population was used. As a result, students who were enrolled in a class other than a standard 9th grade English class would be included in this population group. This could include students who were in honors-level or remedial-level courses. In either case the control population would include students who were operating at class level, above class level, and below class level. For the purposes of this study, the control population was assumed to be equivalent to the treatment population. The accuracy of this assumption can be validated by comparison of fall scores and subscores on the Ohio Proficiency Test. This assumption is further validated by the fact that the study population

was limited to students who failed the writing portion of the Ohio Proficiency Test during the fall of the year in question.

3.3.2 WRITE

The WRITE population included students who were enrolled in a standard 9th grade English class which used a simple word processor to assist in writing. The software did not contain any of the tutor assistance available in the more advanced version of the tutor. This group was used to study the effect of technology usage alone compared to the use of the more advanced tutor.

3.3.3 R-WISE

The R-WISE population included students who were enrolled in a standard 9th grade English class which used the advanced R-WISE tutor. This group represents the true experimental population in this study.

3.4 DATA ANALYSIS

In all cases, a Chi-Square analysis with a confidence interval of 5% was used to determine the statistical significance of the data. This indicates that if the numbers are statistically significant, then there is at least a 95% certainty that the same statistics would be observed in other, equivalent, populations. Tabular representations of all of the data presented are included in the appendix.

3.4.1 FALL

3.4.1.1 PASS/FAIL ANALYSIS

Due to the fact that the study population was limited to students who failed the OPT in the fall, no comparison can be made in this area.

3.4.1.2 SCORE ANALYSIS

The Chi-Squared analysis of fall scores showed a statistically significant variance in the data; observation of Figure A3-7 shows that the WRITE group performed the best, followed by the R-WISE and control groups.

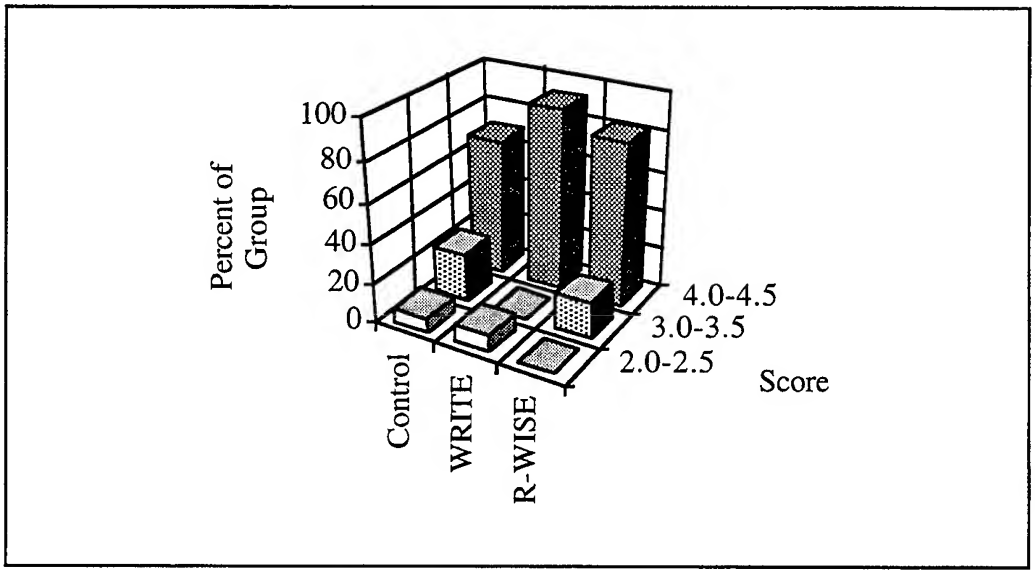

Figure A3-7: Fall score by group for R-WISE analysis.

3.4.1.3 SUBSCORE ANALYSIS

Comparison of the fall subscores between groups showed that the groups were statistically equivalent in all of the areas. This indicates that the groups were equivalent at the beginning of the study and adds validity to the comparison of these groups at the end of the year.

3.4.2 SPRING

3.4.2.1 PASS/FAIL ANALYSIS

This measure of the data gives the clearest representation of the effectiveness of the tutor at helping students pass the OPT. The goal of each student is to pass the test. An increase in

score may suggest an increase in ability, but without passing the test the students and schools do not measure any great improvement. Figure A3-8 displays the percentage of students in each group passing the test during the spring of the year of study. These differences are statistically significant and may represent an improvement as a result of exposure to the R-WISE tutor.

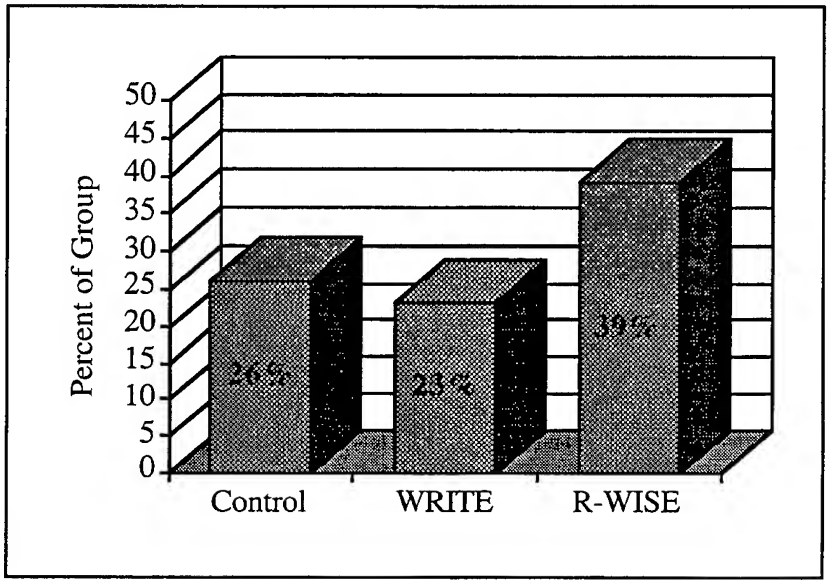

Figure A3-8: Passing percent by group for R-WISE analysis.

The increase in the passing rate for the Control group over the WRITE group suggests that time spent in the computer lab and away from other organized learning activities may have been detrimental to the students. There is a significant increase measured, however, as a result of the features present in the R-WISE version of the software. Again, care must be taken in comparison of the data, particularly in the situation of the Control group and the WRITE group. The difference in the passing rates is small and could easily be attributed to other variables such as teacher differences, curriculum variations, student population differences, and other non-controlled variables.

3.4.2.2 SCORE ANALYSIS

The Chi-Squared analysis of spring scores showed no statistically significant variance in the data. The groups scores were statistically equivalent in the fall and remained that way

in the spring. Therefore, this analysis does not suggest that the R-WISE tutor had any measurable affect on student performance.

3.4.2.3 SUBSCORE ANALYSIS

Comparison of spring subscores by group showed statistical significance only in the area of Content Organization (see Figure A3-9).

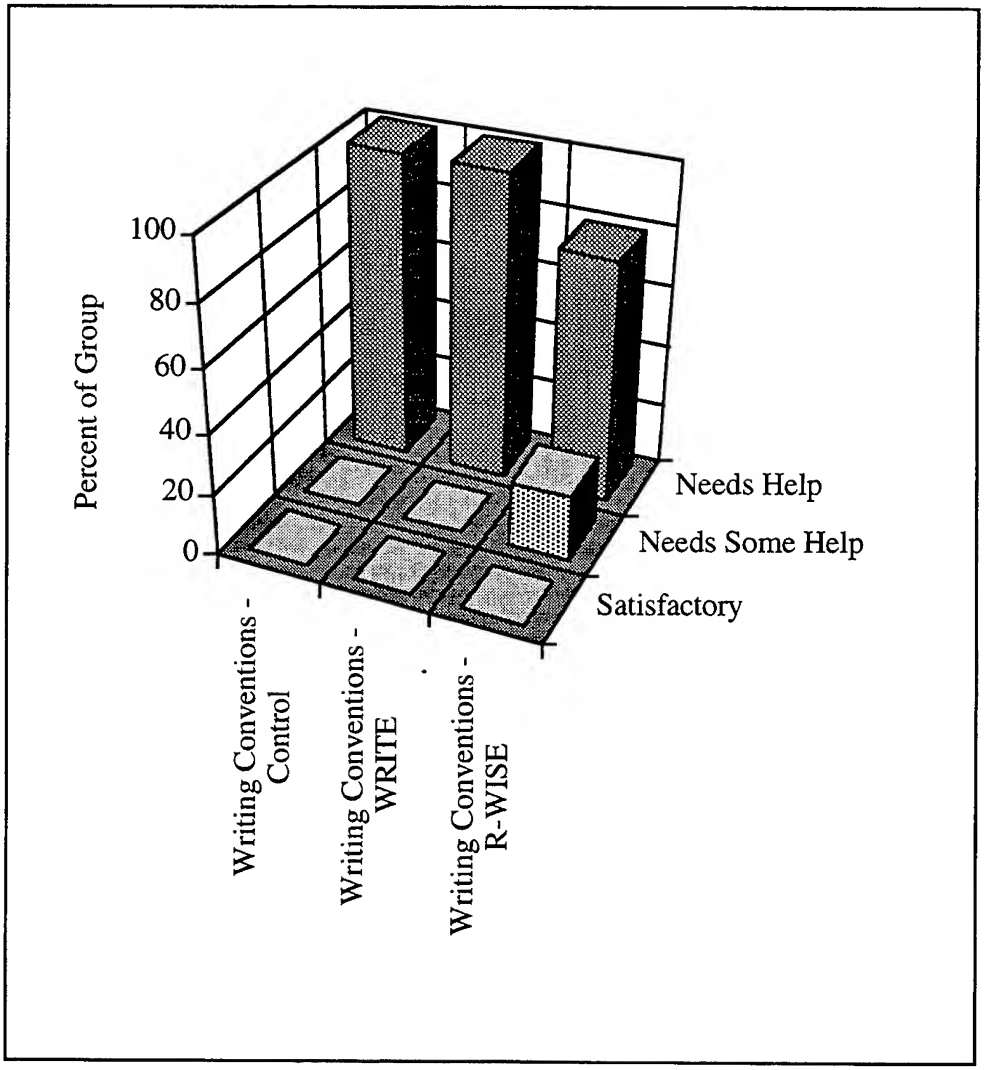

Figure A3-9: Spring subscore analysis by group for R-WISE analysis.

Comparison of the fall and spring results is presented in Table A3-8. In the fall subscore comparison of the three groups, they were statistically equivalent in all areas. After exposure of the R-WISE and WRITE groups to computer-based training, the groups were statistically equivalent in all areas except Content Organization.

Table A3-8: Group which performed the best on a given area of the writing section of the OPT.

	Fall Exam	Spring Exam
Content Organization	Equivalent	R-WISE
Language	Equivalent	Equivalent
Writing Conventions	Equivalent	Equivalent

In the area of Content Organization, the R-WISE group performed the best in the spring. This suggests that the students using the R-WISE tutor were able to improve their performance more than students who were not exposed to the tutor. This suggests that the R-WISE tutor is able to improve student performance on the OPT.

3.5 RESULTS OF R-WISE DATA ANALYSIS

Although a lot of data were collected and analyzed, the most relevant question to be answered relates to the effectiveness of use of the tutor to aid students with passing the OPT. The fact that the study population was limited to students who failed the writing portion of the OPT in the fall, and that the comparison of subscores between groups in the fall showed no significant difference between groups, suggests that the groups were statistically equivalent at the beginning of the school year. The increased passing rate of the students who used the R-WISE tutor over those who did not is significant. This strongly indicates that the R-WISE software may be effective at helping students pass this important exam. The greatest help appears to be in the area of Content Organization which is the area most strongly addressed by the tutor.

Of course, other factors not controlled by the researchers can always affect the observed results. Differences in class curriculums, student populations, teacher experience and style, and mid-year updates of the tutors themselves could all play a part in affecting the data analysis.

However, the data collected to date suggest that the R-WISE software can increase the passing rate of students on the writing portion of the OPT by about 20%.

4.0 CONCLUSIONS

No significant difference was measured in the performance of Practical Algebra students as a result of exposure to the tutor. The performance of Workshop students who were not exposed to the tutor was actually higher than those who were exposed to it. These results suggest that the WPS may not be effective at helping students pass the math section of the Ohio Proficiency Test.

The results of the R-WISE tutor are more promising. Students who used the tutor had a 20% higher passing rate over students who were exposed to traditional instruction alone. These results are encouraging. However, other factors such as student variations, teacher differences, curriculum differences, and other uncontrolled factors could have an effect on these results and must always be considered.

APPENDIX - TABULATED DATA

1.0 WPS TUTOR

1.1 Practical Algebra

1.1.1 Fall Subscore Data

Measurement

	WPS	Control	Total
–	64	41	105
*	25	11	36
+	3	1	4
Total	92	53	145

Arithmetic

	WPS	Control	Total
–	65	39	104
*	23	13	36
+	4	1	5
Total	92	53	145

Geometry

	WPS	Control	Total
–	27	13	40
*	54	32	86
+	11	8	19
Total	92	53	145

Data Analysis

	WPS	Control	Total
–	48	27	75
*	33	22	55
+	11	4	15
Total	92	53	145

Algebra

	WPS	Control	Total
–	46	34	80
*	41	17	58
+	5	2	7
Total	92	53	145

1.1.2 Spring Pass/Fail Data

	WPS	Control	Total
Pass	12	13	25
Fail	80	40	120
Total	92	53	145

1.1.3 Spring Subscore Data

Measurement

	WPS	Control	Total
–	48	27	75
*	31	12	43
+	1	1	2
Total	80	40	120

Arithmetic

	WPS	Control	Total
–	58	31	89
*	20	8	28
+	2	1	3
Total	80	40	120

Geometry

	WPS	Control	Total
–	21	15	36
*	43	21	64
+	16	4	20
Total	80	40	120

Data Analysis

	WPS	Control	Total
–	48	33	81
*	29	7	36
+	3	0	3
Total	80	40	120

Algebra

	WPS	Control	Total
–	38	13	51
*	40	24	64
+	2	3	5
Total	80	40	120

1.2 Workshop Classes

1.2.1 Fall Subscore Data

Measurement

	WPS	Control	Total
–	78	40	118
*	12	12	24
+	2	0	2
Total	92	52	144

Arithmetic

	WPS	Control	Total
–	78	41	119
*	12	10	22
+	2	1	3
Total	92	52	144

Geometry

	WPS	Control	Total
–	43	17	60
*	43	26	69
+	6	9	15
Total	92	52	144

Data Analysis

	WPS	Control	Total
–	53	28	81
*	37	21	58
+	2	3	5
Total	92	52	144

Algebra

	WPS	Control	Total
–	60	33	93
*	28	18	46
+	4	1	5
Total	92	52	144

1.2.2 Spring Pass/Fail Data

	WPS	Control	Total
Pass	13	15	28
Fail	74	37	111
Total	87	52	139

1.2.3 Spring Subscore Data

Measurement

	WPS	Control	Total
–	49	24	73
*	23	13	36
+	2	0	2
Total	74	37	111

Arithmetic

	WPS	Control	Total
–	60	19	79
*	13	16	29
+	1	2	3
Total	74	37	111

Geometry

	WPS	Control	Total
–	35	12	47
*	34	18	52
+	5	7	12
Total	74	37	111

Data Analysis

	WPS	Control	Total
–	42	24	66
*	31	13	44
+	1	0	1
Total	74	37	111

Algebra

	WPS	Control	Total
–	35	14	49
*	32	22	54
+	7	1	8
Total	74	37	111

2.0 R-WISE TUTOR

2.1 Fall Score Data

	R-WISE	WRITE	CONTROL	TOTAL
2	1	1	3	5
3	27	0	10	37
4	126	11	29	166
Total	154	12	42	208

2.1 Fall Subscore Data

Content Organization

	R-WISE	WRITE	CONTROL	TOTAL
NH	137	10	39	186
NSH	17	2	3	22
S	0	0	0	0
Total	154	12	42	208

Language

	R-WISE	WRITE	CONTROL	TOTAL
NH	92	8	28	128
NSH	49	4	9	62
S	13	0	5	18
Total	154	12	42	208

Writing Conventions

	R-WISE	WRITE	CONTROL	TOTAL
NH	76	5	21	102
NSH	36	4	13	53
S	42	3	8	53
Total	154	12	42	208

2.3 Spring Pass/Fail Data

	R-WISE	WRITE	CONTROL	TOTAL
Pass	61	3	34	72
Fail	93	9	8	136
Total	154	12	42	208

2.4 Spring Score Data

	R-WISE	WRITE	CONTROL	TOTAL
2	3	0	5	8
3	24	1	10	25
4	66	8	19	93
Total	93	9	34	136

2.5 Spring Subscore Data

Content Organization

	R-WISE	WRITE	CONTROL	TOTAL
NH	72	9	34	115
NSH	19	0	0	19
S	0	0	0	0
Total	91	9	34	134

Language

	R-WISE	WRITE	CONTROL	TOTAL
NH	49	5	27	81
NSH	28	3	6	37
S	14	1	1	16
Total	91	9	34	134

Writing Conventions

	R-WISE	WRITE	CONTROL	TOTAL
NH	43	2	20	65
NSH	22	2	7	31
S	26	5	7	38
Total	91	9	34	134